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AMERICAN JOURNAL OF OPHTHALMOLOGY

VOLUME 27 SEPTEMBER, 1944 NUMBER 9

CHOLINE ESTERS WITH MYDRIATIC AND CYCLOPLEGIC ACTION*

KENNETH C. SWAN, M.D., AND NORMAN G. WHITE, M.S.
Iowa City, Iowa

Before a previous meeting of this Society, the authors[1] reported that the corneal penetration of drugs was profoundly affected by their physical properties. For example, the onset and intensity of corneal anesthesia induced by a group of topical anesthetics could be correlated with their surface activity. It was conceived that modifications in physical properties might likewise intensify or even alter the ocular effects of autonomic drugs. Choline esters were the first autonomic drugs so modified.[2] Some of the results are reported herein.

The most characteristic action of previously known choline esters is stimulation of structures innervated by the parasympathetic nervous system; for example, the ocular effects of acetylcholine are miosis and spasm of accommodation resulting from stimulation of the iris sphincter and ciliary muscles. Many other choline esters have been synthesized, but in their preparation emphasis was placed on the development of more stable and potent compounds than acetylcholine, such as carbamylcholine. The possibility of reversing the characteristic action of acetylcholine did not receive consideration. Moreover, no attempts were made to correlate the pharmacologic action and the physical properties of the choline esters prior to this investigation.

The physical properties of organic molecules are determined by the characteristics and interrelationships of their component chemical groups. Choline contains a dominant quaternary ammonium group which has a very high affinity for water; consequently, choline and acetylcholine salts (fig. 1) are hygroscopic and relatively surface inactive. A review of the literature revealed no simple choline esters in which the highly hydrophilic quaternary ammonium group had been counteracted or balanced by addition of a large hydrophobic group to the molecule. Investigation of this possibility necessitated synthesis of a new compound in which the highly water-soluble choline group was combined through an ester linkage to a large water-insoluble hydrocarbon group. The resultant elongated molecules would be expected to orient themselves at the surfaces of water solutions and thereby lower surface tension (fig. 2). Such surface-active molecules penetrate living cells rapidly, alter cellular permeability, induce alterations in enzyme systems, and otherwise profoundly influence cellular physiology. Therefore, conversion of a choline ester from a surface-active compound would be expected to influence its pharmacologic action.

Carbamylcholine (doryl), most potent and stable of previously known simple

*From the Department of Ophthalmology, College of Medicine, State University of Iowa. Part of a study being conducted under a grant from the John and Mary R. Markle Foundation. Read at the fourteenth scientific meeting of The Association for Research in Ophthalmology, at Chicago, June 13, 1944.

choline esters, was selected for the initial conversion to a surface-active compound. The hydrophilic NH_2 group was replaced by a water-insoluble group, di-butylamine

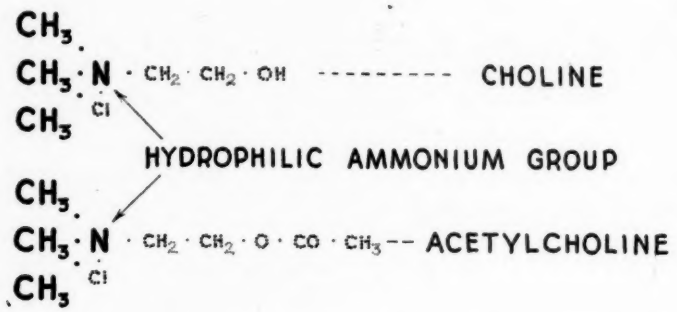


Fig. 1 (Swan and White). Dominant hygroscopic groups in choline and acetylcholine.

(fig. 3). The resultant surface-active compound, di-n-butyl-carbamylcholine chloride, was found to have ocular effects the reverse of those of carbamylcholine. Whereas carbamylcholine produced miosis and spasm of accommodation, the new drug produced mydriasis and cycloplegia.

The ocular pharmacology of di-n-butyl-carbamylcholine has been reported in detail elsewhere.[8] The new drug produces mydriasis by inhibition of the iris sphincter, and also recession of the near point of accommodation. Its effects on the intraocular muscles, therefore, simulate oculomotor nerve paralysis. Miosis and spasm of accommodation induced by eserine, pilocarpine, and carbamylcholine are effectively antagonized. Di-n-butyl-carbamycholine has little effect on the extraocular muscles of mammals or on the iris muscles of birds which are of the striate type. Likewise, the smooth muscle

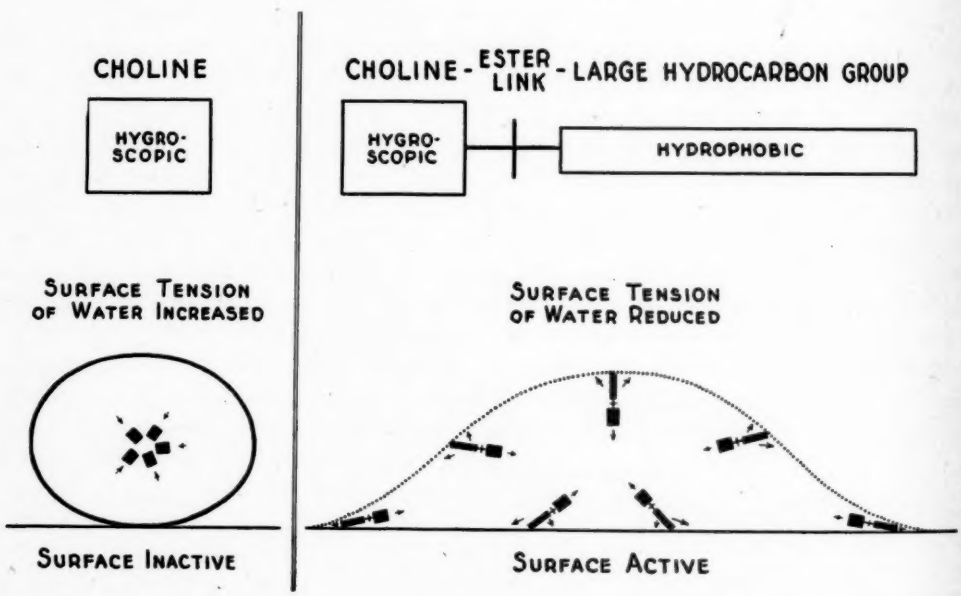


Fig. 2 (Swan and White). Structure and mode of action of surface-active choline esters.

of the lid and the iris dilator fibers, both innervated by the sympathetic nervous system, are unaffected.

The exact site of action of the new drug has not yet been determined; however, there is evidence that its major action is peripheral; that is, upon either the nerve endings or muscle cells. Retrobulbar injections of di-n-butyl-carbamylcholine result in prompt mydriasis in living cats and rabbits; however, retrobulbar injections made immediately after cessation of the circulation* have little effect on the pupil, although intracorneal injections still produce some mydriasis. Therefore, it is probable that mydriasis following retrobulbar injections results from the drug being carried to the intraocular muscles by the ciliary vessels rather than from action of the drug upon the ciliary nerves and ganglion.

From these experiments it is evident that the new drug has the same general site of action as have previously known choline esters, but its effects are opposite. This reversal of action of carbamylcholine by the addition of hydrophobic groups is unprecedented in autonomic pharmacology. Several autonomic drugs, notably nicotine, produce stimulation in small doses and depression in large, but the reversal of action of carbamylcholine by addition of butyl groups is not a dosage phenomenon. Even in threshold concentrations in the aqueous humor, mydriasis produced by di-n-carbamylcholine is not preceded by miosis. Moreover, di-n-butyl-carbamylcholine is not chemically related to previously known drugs with mydriatic and cycloplegic action; for example, the atropine series. Therefore, it must represent a new class of autonomic drugs.

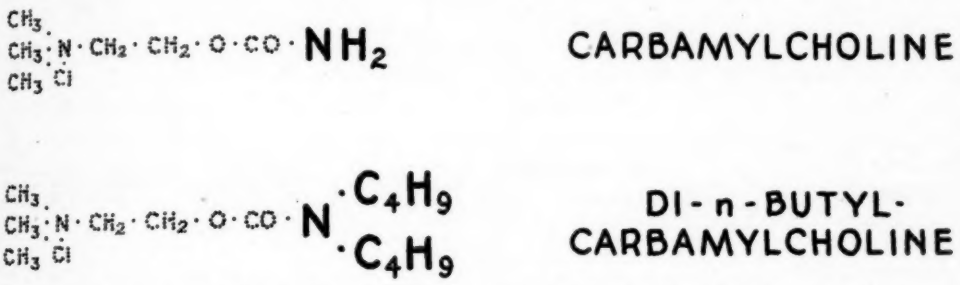


Fig. 3 (Swan and White). Substitution of a water-insoluble amine for the hydrophilic NH_2 group in carbamylcholine (doryl).

To determine the most effective member of the new class as well as to correlate pharmacologic action with chemical structures and physical properties, a number of compounds closely related to di-n-butyl-carbamylcholine were synthesized by the authors. The di-butylamine group was replaced by other aliphatic amines of varying size and affinity for water. As shown in table 1, the surface-active derivatives were mydriatics and cycloplegics whereas carbamylcholine (doryl) and its surface-inactive derivatives were miotic and cyclotonic drugs. The di-propyl-amine derivative was intermediate in surface activity and had little pharmacologic activity. In a second series of new compounds, aromatic hydrocarbon groups rather than simple carbon chains were substituted for the butyl groups. Again the surface-active compounds were mydriatics and cycloplegics whereas the surface inactive compounds were mydriatics and cyclotonic drugs (table 2). In both series balancing of the hydrophilic quater-

*Cessation of circulation was determined by examination of the retinal and conjunctival vessels.

nary ammonium group in choline with a hydrophobic group of sufficient size to effect a marked increase in surface activity seemed essential for mydriatic and cycloplegic action. Rather than the addition of a specific chemical group, substitution of any water-insoluble amine for the hydrophilic NH_2 group in carbamylcholine (doryl) seemed effective.

TABLE 1

CHEMICAL STRUCTURE, SURFACE TENSION, AND PHARMACOLOGIC ACTION OF ALIPHATIC DERIVATIVES OF CARBAMYLCHOLINE

COMPOUND	STRUCTURE			SURFACE TENSION of 5% Aqueous Sol. Dynes per cm. 25°C.		PHARMACOLOGIC ACTION
	CHOLINE SALT	ESTER LINK	AMINE AND ITS WATER SOLUBILITY			
CARBAMYLCHOLINE (DORYL)	$(CH_3)_3 \cdot N \cdot (CH_2)_2 \cdot Cl$	$O \cdot \overset{O}{\overset{\|}{C}} \cdot$	$N(H)(H)$ (Water Soluble)	Relatively Surface Inactive	67	STRONG MIOTIC
DIMETHYL-CARBAMYLCHOLINE	"	"	$N(CH_3)(CH_3)$ (Water Soluble)		64	MIOTIC
DIETHYL-CARBAMYLCHOLINE	"	"	$N(CH_2 \cdot CH_3)(CH_2 \cdot CH_3)$ (Water Soluble)		62	WEAK MIOTIC
DIPROPYL-CARBAMYLCHOLINE	"	"	$N((CH_2)_2 \cdot CH_3)((CH_2)_2 \cdot CH_3)$ (Slightly Water Soluble)		59	INACTIVE
DIBUTYL-CARBAMYLCHOLINE	"	"	$N((CH_2)_3 \cdot CH_3)((CH_2)_3 \cdot CH_3)$ (Water Insoluble)	Surface Active	41	STRONG MYDRIATIC AND CYCLOPLEGIC
BUTYL-AMYL-CARBAMYLCHOLINE	"	"	$N((CH_2)_3 \cdot CH_3)((CH_2)_4 \cdot CH_3)$ (Water Insoluble)		39	MYDRIATIC AND CYCLOPLEGIC
DIAMYL-CARBAMYLCHOLINE	"	"	$N((CH_2)_4 \cdot CH_3)((CH_2)_4 \cdot CH_3)$ (Water Insoluble)		38	MYDRIATIC AND CYCLOPLEGIC

To study further the apparent relationship between physical properties and pharmacologic action of the choline esters a third series of compounds was synthesized in which surface activity was varied by modification made at the choline rather than at the carbamate end of the molecule. The hydrophilic properties of the quaternary ammonium group were varied while the hydrophobic character of the carbamate end of the molecule was not altered. As shown in table 3, replacing one of the methyl groups in di-n-butyl-carbamylcholine by an ethyl group increased both surface and pharmacologic activity of the compound. This compound, dibutoline, proved to be the most effective of the new class of drugs. When the methyl groups at the choline end of di-n-butyl-carbamylcholine were otherwise replaced by ethyl, propyl, or butyl groups, surface activity and pharmacologic potency were reduced. The hydrophilic character of the ammonium end of the molecule was also reduced by substituting di-ethyl and dimethyl groups in place of the tri-methyl (fig. 4). These tertiary amines were less surface active, and their mydriatic and cycloplegic actions weaker than those of

TABLE 2

CHEMICAL STRUCTURE, SURFACE ACTIVITY, AND PHARMACOLOGIC ACTION OF AROMATIC DERIVATIVES OF CARBAMYLCHOLINE

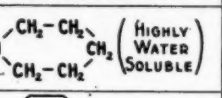
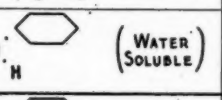
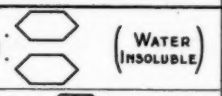
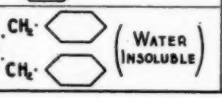
COMPOUND	STRUCTURE			SURFACE TENSION OF 5% AQUEOUS SOL. DYNES PER CM. 25°C.		PHARMACOLOGIC ACTION
	CHOLINE SALT	ESTER LINK	AMINE AND ITS WATER SOLUBILITY			
PIPERIDINE DERIVATIVE	$(CH_3)_3 \cdot N \cdot (CH_2)_2 \cdot Cl$	$O \cdot \overset{O}{\overset{\|}{C}} \cdot$	 (HIGHLY WATER SOLUBLE)	SURFACE INACTIVE	61	MIOTIC
PHENYL-CARBAMYLCHOLINE	"	"	 (WATER SOLUBLE)	SURFACE INACTIVE	60	MIOTIC
DIPHENYL-CARBAMYLCHOLINE	"	"	 (WATER INSOLUBLE)	SURFACE ACTIVE	42	MYDRIATIC AND CYCLOPLEGIC
DIBENZYL-CARBAMYLCHOLINE	"	"	 (WATER INSOLUBLE)	SURFACE ACTIVE	48 SATURATED SOL. (LESS THAN 3%)	MYDRIATIC AND CYCLOPLEGIC

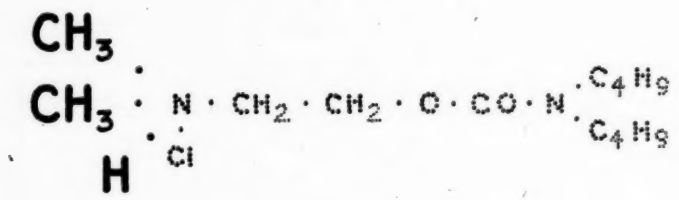
TABLE 3

CHANGES IN SURFACE ACTIVITY AND MYDRATIC ACTION RESULTING FROM MODIFICATIONS IN THE QUATERNARY AMMONIUM GROUP

COMPOUND	STRUCTURE		SURFACE TENSION OF 5% AQUEOUS SOL. DYNES PER CM. 25°C.	COMPARATIVE MYDRIATIC ACTION (RABBIT)
DI-n-BUTYL-CARBAMYLCHOLINE	CH_3, CH_3, CH_3	$N \cdot (CH_2)_2 \cdot O \cdot \overset{O}{\overset{\|}{C}} \cdot N(C_4H_9)(C_4H_9)$	40	+ + +
DIMETHYL-ETHYL-DERIVATIVE (DIBUTOLINE)	CH_3, CH_3, C_2H_5	"	36	+ + + +
DIETHYL-METHYL-DERIVATIVE	C_2H_5, C_2H_5, CH_3	"	41	+ + +
TRIETHYL-DERIVATIVE	C_2H_5, C_2H_5, C_2H_5	"	41	+ + +
TRIBUTYL-DERIVATIVE	C_4H_9, C_4H_9, C_4H_9	"	56	±
DIMETHYL-PROPYL DERIVATIVE	CH_3, CH_3, C_3H_7	"	43	+ +

the corresponding quaternary compounds.

Physical properties, particularly surface activity, seem intimately related to the reversal of action of carbamylcholine, but other factors influence the potency and toxicity of the new class of drugs. The most highly surface-active compounds, the di-amyl derivatives, are less potent than the less surface-active di-butyl series; that is, there appears to be an optimum size for the hydrophobic group added to carbamylcholine (doryl) for maximum mydriatic and cycloplegic action. Also, modifications (fig. 5) which do not significantly affect surface tension, profoundly alter the potency and toxicity of the drugs. For example, the surface-active betamethylcholine derivatives retain mydriatic and cycloplegic action but are much less potent than the corresponding cholines. The surface-active homocholine derivatives, unlike the corresponding cholines, are highly toxic. Finally, the carbamate group seems to contribute to the potency of the new class. Surface-active esters of choline such as the palmitate and the fluorene-9-carboxylate which lack the carbamate group have only weak antispasmodic effects on the iris sphincter. The favorable influence of the car-



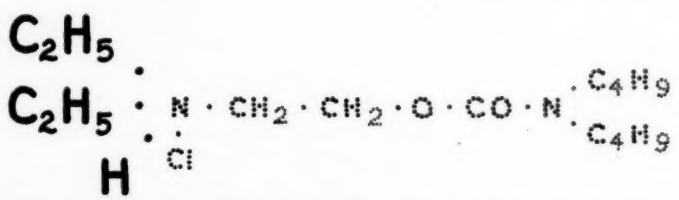


Fig. 4 (Swan and White). Surface-active carbamic acid esters of di-methyl and di-ethyl amino ethyl alcohol.

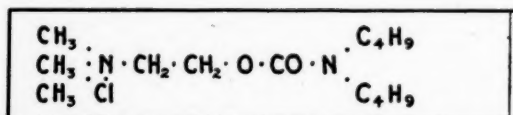
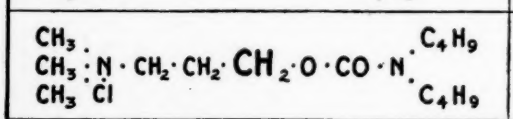
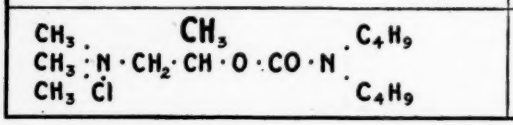
	DI-n-BUTYL-CARBAMYLCHOLINE CHLORIDE
	DI-n-BUTYL-CARBAMYL-HOMO-CHOLINE CHLORIDE
	DI-n-BUTYL-CARBAMYL-BETA-METHYL-CHOLINE CHLORIDE

Fig. 5 (Swan and White). Structural modifications in the center of the di-n-butyl-carbamyl choline chloride molecule.

bamate group probably results from its inhibitory action on choline esterases;[4] consequently, carbamic acid esters of choline are more stable and, therefore, more potent than esters like acetylcholine which are rapidly hydrolyzed in the tissues. The latter have only fleeting action.

Dibutoline, the most effective of the new class of drugs, is relatively surface active in ionic form. Surface-active drugs penetrate the cornea readily and have antibacterial action; however, high concentrations or repeated instillations produce conjunctival irritation and punctate disturbances of corneal epithelium.[5] For clinical purposes, it was desirable to find a salt of dibutoline which would be only partially ionized in therapeutic concentrations and therefore less apt to cause conjunctival irritation. It was found that whereas the 5-percent solutions of the chloride salt of dibutoline were almost completely ionized and had an interfacial tension of 36 dynes per cm. at 25°C., equimolecular solutions of a double salt, the sulfate, were only partially ionized and had an air-water interfacial tension of 47 dynes (table 4). Five-percent solutions of the former are irritating when instilled into the conjunctival sac, whereas single instillations of the sulfate salt are well tolerated. No difference has been noted in pharmacologic activity of the different salts, probably owing to the fact that in the intraocular tissues dibutoline exists in minute concentrations, and therefore, is highly ionized. The ocular pharmacology and clinical use of dibutoline sulfate are reported in detail elsewhere.[6]

TABLE 4

SURFACE ACTIVITY AND DEGREE OF CONJUNCTIVAL IRRITATION PRODUCED BY AQUEOUS SOLUTION OF VARIOUS DIBUTOLINE SALTS

DIBUTOLINE SALT	SURFACE TENSION OF 5% AQUEOUS SOL. DYNES PER CM. 25°C.	CONJUNCTIVAL IRRITATION FROM SINGLE INSTILLATIONS OF 5% SOLUTIONS
IODIDE	36	++
CHLORIDE	39	++
METHYL SULFATE	45	+
SULFATE	47	±

DISCUSSION

The discovery of an apparent relationship between the pharmacologic action and physical properties of the carbamylcholine series may provide a basis for the development of other new therapeutic agents. Therefore, a theoretical discussion of the possible mode of action of the new class of drugs is of practical importance. The most plausible theory is that the new drugs act as "inhibitory analogues" of acetylcholine. An "inhibitory analogue" is a compound which, by virtue of its chemical similarity to a normal metabolite, replaces the latter in the tissues but is incapable of fulfilling its meta-

bolic functions; consequently, physiologic functions dependent upon the presence of the normal metabolite are interrupted. There are numerous examples in bacterial metabolism, notably para-aminobenzoic acid and para-amino-benzene-sulfonamide (sulfanilamide.[7]) The latter is thought to inhibit the multiplication of certain bacteria by competing with the normal metabolite, para-amino-benzoic acid, for enzymes essential for growth. A similar relationship may exist between the new series of cholinelike esters and acetylcholine. Acetylcholine normally is involved in the mediation of nerve impulses to tissues like the iris sphincter and ciliary muscles. The new compounds are chemically similar to acetylcholine but are surface active and, therefore, would be expected to have the greater affinity for the tissues. If the new drugs displaced acetylcholine from the muscle-receptor system but were incapable of fulfilling its role in the normal transmission of nerve impulses, relaxation of the involved muscle would result.

Summary and Conclusions

Balancing of the hydrophilic quaternary ammonium group in carbamylcholine (doryl) with hydrophobic carbon groups results in a reversal of its pharmacologic action on the intraocular muscles. Whereas carbamylcholine (doryl) produces miosis and cyclotonia, di-n-butyl-carbamylcholine produces mydriasis and cycloplegia. Correlation of physical properties with the pharmacologic action of other new drugs synthesized by the authors indicates that the unique reversal of action of carbamylcholine seems dependent upon its conversion to a surface-active compound. The surface-active carbamylcholine derivatives have a potent peripheral antispasmodic action on the smooth muscles of the eye innervated by the parasympathetic nervous system; that is, the iris sphincter and ciliary muscles. The mydriatic and cycloplegic effects of other surface-active choline esters are considerably weaker.

The surface-active carbamylcholine derivatives are chemically unrelated to previously known mydriatic and cycloplegic agents—for example, the atropine series—and, therefore, constitute a new class of drugs. For clinical purposes the sulfate appears to be the most satisfactory salt and dibutoline the most effective member of the new class. It is suggested that the new drugs may act as "inhibitory analogues" of acetylcholine.

3181 S.W. Marquam Hill Rd., Portland, Oregon.

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A QUANTITATIVE TEST FOR MEASURING DEGREE OF RED-GREEN COLOR DEFICIENCY*

LOUISE L. SLOAN, PH.D.
Randolph Field, Texas

The types of color-vision test needed for the classification of Air Force personnel are (1) a simple, rapid, and reliable screening test that will distinguish the normal from the color-deficient applicants, and (2) a supplementary quantitative test that will classify the latter group as to the degree of defect, and will be of aid in determining whether the applicant is competent to make the color discriminations required in his particular job.

The Color-Threshold Tester was devised for use as such a supplementary test. Since recognition of colored-light signals is generally considered to be among the most important and most difficult of the color discriminations required of air-crew members, a color-naming test was developed that would involve ability to recognize colored lights of low intensity subtending small visual angles.

The colors used in airport beacons, airway-course lights, airport-boundary and strip lights, traffic-control projectors, obstruction lights, approach lights, and so forth, must meet the specifications set by the Bureau of Standards for Aviation Colors. The allowable variation in hue and saturation is defined in terms of standard "limit glasses" used in combination with a standard light source. To stimulate in a test the conditions involved in the recognition of colored-light signals, the test lights should be of high purity and should differ markedly in dominant wave-length. They should, however, be of low intensity and subtend a small visual angle.

The Color-Threshold Tester consists essentially of the following parts: (1) a 60-watt lamp enclosed in a lamp house, (2) a diffusing milk-glass surface illuminated to the desired brightness by adjustment of the distance of the lamp from the surface, (3) a disc containing three apertures for varying the size of the test field, (4) a disc with eight apertures containing neutral filters for varying the brightness of the test field, (5) a disc with eight apertures containing color filters for varying the color of the test field, (6) guide lights located on either side of the test field for controlling fixation.

The aperture disc contains three circular openings one-eighth, one-fourth, and one inch in diameter. When the subject is 10 feet from the lantern, the smallest aperture subtends a visual angle of 3 minutes, 40 seconds. (If the tests are made at a distance of 20 feet, the one-fourth inch aperture is used. The one-inch aperture is used only in calibrating the instrument.) Two small holes drilled in the front of the lamp house at 2½ inches from the test field on the right and on the left, covered with blue gelatine filters (Wratten No. 46), provide tiny blue lights which serve as guide lights for controlling fixation. They also serve to orient the lantern properly with respect to the subject, because if the lantern is turned away appreciably one or the other of the guide lights will be hidden.

The intensity disc contains Wratten neutral filters of the following densities: 2.1, 1.8, 1.5, 1.2, 0.9, 0.6, 0.3, 0.0. By

* Read at the fourteenth scientific meeting of the Association for Research in Ophthalmology, in Chicago, June 13, 1944.

means of this disc the brightness of the test field can be varied over a range of 2.1 log units in steps of 0.3 log unit. Each successive brightness level is, therefore, double the preceding one.

Test lights of eight different colors are used: two reds, two yellows, two greens, a blue, and a white. The choice of filters for these colors was based principally on two considerations: (1) They should provide colors close to the limiting standards for Aviation Colors, since these are the more difficult for both normal and color-deficient subjects; (2) they should include colors of particular difficulty for the color-deficient subject. Although red-green color-deficient persons probably see the blue, yellow, and white lights essentially as they appear to the normal, it is important that they be included, because their presence makes the correct naming of red and green more difficult for the color-deficient subjects. One of the reds used in the instrument approximates the yellow limit of Aviation Red, which may be difficult to distinguish from a reddish yellow; the other is a longer wave-length red, which at low intensity may not be visible at all to the protanopic type of the color deficient. The two greens and the two yellows used are within, but close to, the "limiting" Aviation Colors. The blue is within, but close to, the green limit for Aviation Blue. The white light is close to the blue limit for Aviation White. In a test in which the color-deficient individual is required to name colors, it is particularly important to include a white light, because confusion of green and white is characteristic of this group and because they more frequently call a white light green than they call a green light white. Blue is seldom used as a signal or recognition light at the present time, and at low intensities is easily confused with green even by those with normal color vision. It has been included, however, in order to make the test a more complete and more fundamental measure of color discrimination.

The minimum intensity at which each of the eight test lights is shown is so chosen that all but a small percentage of those with normal color vision can identify the color at this level of intensity. At the lowest level of intensity, therefore, the eight colors are of approximately equal *difficulty* insofar as recognition of the color is concerned, but are not of equal intensity. The intensities of the eight colors at the second level are double the minimum values and are, therefore, again approximately equal to one another in "difficulty" but not in intensity. At each succeeding level the brightnesses are increased by 0.3 log unit.

Procedure

The test is made in a dark room. The subject is first shown the eight colors at the highest level of intensity by placing the intensity control wheel at level No. 8. The color wheel is started at No. 8 and turned clockwise. As the colors are shown, they are named by the operator as green, white, red, yellow, blue, green, orange or amber, and red. The subject is told that he must use only these terms in naming the colors to be shown him. He is instructed to look midway between the two guide lights. The intensity control is then set at level No. 1 by turning it one step clockwise, and the eight colors from No. 1 to No. 8 are shown at this level. The intensity control is then shifted to level No. 2 and the eight colors are shown in the reverse order from No. 8 to No. 1. The operator proceeds in this manner until all eight colors have been shown at each of the eight levels of intensity. It has been found that no preliminary period of dark adaptation is required other than the minute or so taken in explaining the procedure and showing the colors at the

highest intensity, *unless* the subject has just come in from out-of-doors.

Method of scoring

Table 1 shows a series of typical records for color-deficient subjects with various degrees of defect. It will be seen that the errors characteristic of the color-deficient group are confusion of green with white, amber with red, and failure to see the red light at all at low intensities. Both normal and color-deficient subjects, on the other hand, confuse blue with green in this test, yellow with white, and amber with yellow. Color-deficient subjects frequently name a color correctly in the middle range of intensities and yet make characteristic errors at higher intensities. This may be due to chance guessing of the correct answer, but is probably also

TABLE 1

Typical Records on Color-Threshold Tester

I

	1r	2a	3g	4b	5y	6r	7w	8g
1	—	r	b	—	r	r	r	w
2	y	y	w	w	y	r	w	w
3	y	y	g	g	y	r	y	g
4	r	y	g	g	y	r	y	g
5	r	y	g	g	y	r	w	g
6	r	o	g	g	y	r	y	g
7	r	o	g	b	o	r	w	g
8	r	o	g	b	o	r	w	g
Score 52	5	7	6	6	7	8	7	6
Answers counted correct	r	o a y	g b	b g	y w a o	r	w y	g b

II

	1r	2a	3g	4b	5y	6r	7w	8g
1	r	y	g	r	y	r	w	g
2	r	y	w	b	y	r	y	g
3	r	y	g	b	y	r	y	g
4	r	y	w	r	y	r	w	g
5	r	y	g	g	y	r	g	g
6	r	y	g	g	y	r	y	w
7	r	y	g	b	y	r	w	g
8	r	y	g	b	y	r	g	w
Score 40	8	8	4	4	8	8	0	0

III

	1r	2a	3g	4b	5y	6r	7w	8g
1	—	g	b	—	g	—	b	—
2	b	w	g	b	g	—	w	b
3	g	w	b	b	g	b	w	g
4	b	o	g	b	w	g	w	g
5	g	o	b	b	o	g	w	b
6	r	o	g	b	o	r	w	w
7	r	o	g	b	o	r	g	g
8	r	o	g	b	o	r	w	g
Score 34	3	5	8	7	5	3	1	2

IV

	1r	2a	3g	4b	5y	6r	7w	8g
1	b	r	b	g	a	g	g	b
2	b	a	w	b	y	g	a	w
3	g	y	w	g	r	r	w	a
4	g	r	w	b	y	r	r	w
5	y	y	g	b	y	r	a	w
6	r	r	w	b	r	r	w	y
7	a	r	b	b	r	r	w	w
8	a	r	w	b	r	r	w	w
Score 17	0	0	0	8	0	6	3	0

due in part to the fact that the color deficient associate certain brightnesses with certain color names.

The method of scoring adopted was chosen after considerable experience with the test, because it gives the highest reproducibility of scores in repeated tests and the greatest differentiation between the scores of normal and color-deficient subjects. The answers which are counted correct for each color are shown in Record I in Table 1.*

The numerical score is obtained as follows: The part score for each of the eight test lights is obtained by counting the correct responses starting from intensity level No. 8 and continuing to lower intensities until an error occurs. *Correct responses at still lower levels are not counted.* The score for the entire test is the sum of the eight part scores.

The method of scoring in which correct responses at lower levels of intensity are not counted when an error is made at a higher intensity puts a greater penalty on mistakes made at high than at low intensities; this is in accord with practical considerations, since errors in recognition of colors of higher intensity are more serious in actual practice. This method of scoring also takes into account the characteristic differences in the responses of normal and color-deficient subjects. It was found that if the test is scored by simply counting the total number of errors, it does not provide so efficient a means of differentiating these two groups as when it is scored in the manner described.

TABLE 2

DISTRIBUTION OF SCORES ON COLOR-THRESHOLD TEST FOR NORMAL AND COLOR-DEFICIENT SUBJECTS

Scores	Percent of Cases		Score Equal To Or Greater Than	Percent of Cases	
	200 Normals	209 Color Deficient		200 Normals	209 Color Deficient
64–60	95.0	12.0	60	95.0	12.0
59–55	4.5	12.4	55	99.5	24.0
54–50	0.5	12.4	50		37.0
49–45	0.0	12.4	45		49.0
44–60		16.3	40		66.0
39–35		11.5	35		77.0
34–30		9.6	30		87.0
29–25		5.3	25		92.0
24–20		3.4	20		95.0
19–15		3.4	15		98.5
14–10		1.0			
9 or less		0.5			

Table 2 shows the distribution of scores of 200 normal and 209 color-deficient subjects. It may be seen that 95 percent of the normal group and 12 percent of the color-deficient group make scores of 60 or bettter. The scores of the remaining 88 percent of the color-deficient group range from 59 to 9.

In order to determine the reproducibility of the scores, 98 color-deficient subjects were given two independent tests. In 58 cases the second test was given immediately after the first, in 43 cases the two tests were made on different days. The results are summarized in table 3, which shows the mean scores, the standard deviations, and the test-retest correlation. In interpreting these values, it should be remembered that the scores

* It might be thought that since blue may be called green, white called yellow, and so on, the test could be simplified by the omission of some of the colors. It is probable, however, that reduction in the number of colors used would make the test less satisfactory in differentiating degrees of defective color perception.

TABLE 3

TEST-RETEST RESULTS ON COLOR-THRESHOLD TEST FOR 98 COLOR-DEFICIENT SUBJECTS

	No. of Cases	Mean Score Test 1	Mean Score Test 2	Standard Deviation Test 1	Standard Deviation Test 2	Correlation Coefficient
Two tests Same session	55	44.2	44.9	14.4	14.7	plus 0.94
Two tests Different days	43	45.3	45.8	12.1	10.1	plus 0.80

on this test do not show a normal distribution. The mean scores in the two tests show no evidence of improvement due to practice, whether the second test is given immediately after the first or on another day.

It is of interest to know the extent to which the scores on this test are related to scores on tests measuring other aspects of color discrimination. One hundred color-deficient subjects given the Color-Threshold Test were also given five other color-vision tests; namely, (1) a modified RCN Lantern, (2) a short-

TABLE 4

RELATIONSHIP BETWEEN SCORES OF VARIOUS TESTS (100 COLOR-DEFICIENT SUBJECTS)

		Score, Color-Threshold Test 64–53	52–40	39–18		Number with Same Grade on Both Tests: Observed	Expected on Basis of Chance
Errors Canadian Lantern	0–5	23	7	1	31		
	6–8	8	13	10	31	58	33.3
	9 or more	1	15	22	38		
Errors Simplified Farnsworth Test	0	20	10	5	35		
	1–4	10	16	10	36	54	33.4
	5 or more	2	9	18	29		
Errors Abridged A.O.	4–12	20	10	4	34		
	13–15	5	13	11	29	51	33.2
	16–17	7	12	18	37		
		32	35	33			

		Score, Color-Threshold Test 64–57	56–35	34–18			
Errors Rabkin	1–10	17	9	3	29		
	11–12	6	37	10	53	59	40.9
	13	1	12	5	18		
		24	58	18			

		Score, Color-Threshold Test 64	63–35	34–18			
Grade, Anomaloscope	1	3	2	0	5		
	2	1	70	7	78	84	64.1
	3	0	6	11	17		
		4	78	18			

ened form of the Farnsworth 100-Hue Test, (3) an abridged version of the A.O. Pseudo-Isochromatic Charts, (4) the Rabkin Polychromatic Charts, (5) an anomaloscope (a modified Eastman color temperature meter).

In order to compare the six tests with one another, scores have been chosen for each which define three grades of defect. For three of the tests (the RCN Lantern, A.O., and Farnsworth) it is possible to define these so that about one third of the subjects fall in each grade. In comparing these three tests with the Color-Threshold Test, therefore, the scores on the latter have been chosen to give a similar distribution. Table 4 shows in the form of contingency tables the relationship between the grades on the four tests. It is obvious to inspection that there is some relation between the different tests. If there were no relationship whatsoever, about one third of the group would by chance show the same grade, whereas, for example, 58 of the 100 subjects have the same grade on the Color-Threshold Tester and the Canadian Lantern.

The grades on the Color-Threshold, anomaloscope, and Rabkin tests show a somewhat similar degree of agreement when the score ranges for the Color-Threshold Test are chosen so that the distribution as to the number of individuals in each grade is approximately the same in the two tests compared. These results indicate that an individual with, for example, marked inability to distinguish colored lights of low intensity will *probably* also show poor ability in other tasks requiring color discrimination. Since, however, the agreement with the scores on other tests is not perfect, the quantitative color-vision test chosen for the selection of air-crew personnel should be the one which correlates most closely with practical field tests related to the tasks required of such personnel.

Table 5 shows for color-deficient subjects the relationship between scores on the Color-Threshold Test and the results of practical field tests. One of the field tests consisted in having the subjects identify the red, green, and white signals from a traffic-control light, commonly called a "biscuit gun." The biscuit gun is a hand-

TABLE 5

RELATIONSHIP BETWEEN SCORES ON COLOR-THRESHOLD TEST AND PERFORMANCE IN FIELD TESTS

Color-Threshold Score	Biscuit Gun—1 Mile, at dusk					
	Pass	Fail		Pass	Fail
44–64	24	5	50–64	20	1
43 or less	4	21	49 or less	8	25

	Pyrotechnic Signals, Red and Green				
	6 miles, 5000 ft., at night				
	Pass	Fail		Pass	Fail
44–64	7	2	54–64	4	0
43 or less	1	5	53 or less	4	7

Note:
Scores of 55 or better made by 24 percent of color-deficient group
Scores of 50 or better made by 37 percent of color-deficient group
Scores of 45 or better made by 49 percent of color-deficient group

held signal light, whose essential parts are a lamp, paraboloidal reflector, red and green filters, and a sighting device for directing the beam. With a few exceptions, the 54 subjects took part in two independent tests involving identification of biscuit-gun signals, and were classified as failing if they made any errors in either test. The conditions under which the tests were conducted were such that none of the control group of subjects with normal color vision made any errors.

The data given in table 5 show that there is a fairly close relationship between Color-Threshold scores and ability to identify the "biscuit-gun" signals. If a qualifying score on the Color-Threshold Test of 44 or greater is taken, the results are in agreement with those of the practical field test in 45 of the 54 cases. If the qualifying score is raised to 50, the number who pass the Color-Threshold Test but fail to identify biscuit-gun signals is reduced from five to one.

In a second series of experiments, the subjects were required to identify red, green, and yellow pyrotechnic signals. In these tests the control group of normal subjects made no errors, but only 9 of the 80 color-deficient subjects failed to make errors. These 9 individuals had scores of 57 or greater on the Color-Threshold Test. Because of their small number, it is probably not worth while to attempt to select the color-deficient individuals who are able to distinguish the three pyrotechnic signals. Similar tests in which only red and green flares were used were given to a small group of color-deficient subjects. The results, shown in table 5, suggest that an appreciable number can identify red and green flares if only these two colors are used. As was the case in the tests with the biscuit gun, the scores on the Color-Threshold Test show a fairly close relation to the results of the field tests.

The decision as to whether some color-deficient subjects can safely be qualified for pilots, bombardiers, navigators, or service pilots, and so on, must depend on further study of the color discriminations required of each group. Since the scores on the Color-Threshold Test show a fairly close relationship with actual performance, this test should prove to be of value in selecting those with adequate color vision for certain tasks.

AAF School of Aviation Medicine.

Discussion

Dr. F. C. Cordes (San Francisco): The CAA stresses the importance of distinguishing low intensities of green and brown in depth perception. As an example, in distinguishing a meadow from a plowed field. Does the threshold lantern give us any information on this particular type?

Dr. Sloan: I am glad someone asked that question. There has been a good deal of discussion. It was thought at one time that identifying the nature of the terrain was one of the difficulties that the color blind might encounter. In fact, one of the standard examples was that the men would not be able to tell the swampy ground, which is a bluish-green color, from a nice, smooth grass field, which is yellow-green. What they forget is that this is a blue-yellow discrimination and not a red-green discrimination at all.

The case mentioned would presumably be a red-green discrimination. But for two reasons I do not think red-green color discrimination is an important factor in identification of terrain: All of the color-deficient subjects who took part in these experiments were civilian pilot instructors

limited to day flying. Some of them had quite marked defects, but they never had any difficulty in picking a field for a forced landing. They all laughed when we asked whether color had anything to do with it. They said, "You select a field by the smoothness or whether there are ditches or where the wind is coming from and by the texture rather than by color."

I think the same is true of camouflage. In all the books on camouflage, color is stressed very little. It is the inequalities in surface brightness by which you judge the type of landing field. I would not say that some particular situation might not occur in which confusion of a reddish field with a green field might not be made by a color-blind person. I thought at one time that a plowed field would make a poor landing field, but they tell me that it makes a good landing field if you land in the right direction in relation to the furrows.

We had a pilot fly while wearing red goggles, which eliminated all hue differences. When these are worn for a while everything appears as a washed-out pink. He said that he had no difficulty whatever while wearing them in knowing what the different fields were and he did not believe that color is an important clue. The goggles may have distorted the brightnesses a little, but at least they did not handicap him. We should make such tests on more pilots. In this one case the pilot was perfectly willing to wear red goggles while selecting a landing field.

DR. T. J. DIMITRY (New Orleans): Do women pass these simple tests better than men?

DR. SLOAN: Since I have been at the School of Aviation Medicine I have not tested many women. At the Wilmer Institute I saw one or two color-blind women, but they are extremely rare. I imagine that all the WASPS are given the same tests and I haven't heard of any problem of color blindness there. In standardizing this test, we have given it to the various secretaries around the School, and they make normal scores on it. We have come across one color-blind woman. She is the mother of one of the enlisted men who is color blind. In reading the pseudo-isochromatic charts she makes a few errors. I believe that the women carriers, if tested carefully enough, might show very slight defects.

DR. H. S. GRADLE: How does the test lantern differ from the Williams Test Lantern, and what is the time of exposure of the color field?

DR. SLOAN: I am not very familiar with the Williams Lantern. All of the so-called lantern tests have a great deal in common. Many do not use standardized colors which can be reproduced. The test field in the Williams Lantern is much larger than that in the Color-Threshold Tester, which makes the test easier. One important feature of the test I have described is that colors are shown at very low intensities such that even the normal individual can barely distinguish them.

The other question was about the time of exposure. It has been asked before whether we should control time of exposure. We tried having a shutter, and it just complicated the instrument. We allow about five seconds and then proceed to the next color if we do not get an answer. Even if you had a shutter, you would still have to have some means of regulating the time of exposure. Personally, I do not believe that time of exposure makes too much difference. The normals give the right answer promptly and the color deficient want to take longer. We have tried giving them as long as they want and they still do not give the correct answer.

DR. HARRY S. GRADLE: I remember that six or eight months ago there was a great furor about training color-deficient

men who had been rejected. Have you had any of these men?

DR. SLOAN: Yes. we have had quite a few.

DR. GRADLE: Will you make a statement for us?

DR. SLOAN: One of the treatments for color blindness consists in exposing the eyes to a bright red light. Immediately after this, the subject attempts to read the charts. He is able to see some of them because the preëxposure to red has somewhat the same effect as viewing the charts through a green filter. Similarly, preexposure to green light, which is used next, has somewhat the same effect as viewing the charts through a red filter. When this process is repeated day after day the subject gradually memorizes a number of the charts. We have tested about 10 men who have taken such treatments and they fail on all tests of color vision in which this training is not a factor. The Rabkin Polychromatic Charts, for example, are produced in Russia and are not among those used in training color vision, because they are difficult to obtain. We also use a test similar to Nagel's anomaloscope. This is also failed by the subjects who have taken the so-called "cures" for color blindness. The pseudoisochromatic-chart type of test is not meant for use in repeat tests. These charts work very well if the subjects have not had a chance to study them.

We thought that vitamin A as a cure for color blindness was worthy of a trial. A number of color-deficient individuals took large amounts for three months. They were given a number of different tests before and after but not during the treatment. None showed the slightest evidence of any improvement.

DR. GRADLE: Still I should like you to come out positively: Did this so-called treatment for color blindness have any influence on the color perception of the individual?

DR. SLOAN: Absolutely none.

DR. ALBERT C. SNELL: Do you consider the Ishihara test an adequate screening test for the inductees?

DR. SLOAN: The Ishihara tests that are available in the Army at the moment are so faded that they certainly ought to be condemned. It is not possible to get new ones, so that leaves only the American Optical Company test available. This is not so good a test as the Ishihara. What we have done is to select a series of 17 charts from the complete American Optical edition. We eliminated the charts which the normals read incorrectly, and those that the color blind practically alway read correctly. In the end we had 17 charts that gave a very clean-cut separation. The normals may occasionally make as many as three errors. At least 90 percent of the color-deficient group make 15 to 17 errors; 17 being the maximum possible. There are a number in the color-deficient group who do not fail all of them, but, in general, the abridged version is far better than the complete American Optical Company test, in my opinion. Substitution of the abridged series of charts is something that can be done immediately. There is, however, need for better tests, because with pseudoisochromatic charts there is always the possibility of coaching. I think that eventually they ought to design new pseudoisochromatic charts that cannot be learned or use some other type of screening test.

THE DISSOCIATION OF FORM VISION AND LIGHT PERCEPTION IN STRABISMIC AMBLYOPIA*

GEORGE WALD, PH.D.
Cambridge, Massachusetts
AND
HERMANN M. BURIAN, M.D.
Hanover, New Hampshire

INTRODUCTION

The amblyopia associated with strabismus is distinguished from other types of reduced visual acuity in two ways: (a) the amblyopic eye is ophthalmoscopically normal in every respect; and (b) its visual acuity can be improved in certain cases and to various degrees by prolonged occlusion of the dominant eye.

Until both these characteristics had been adequately established it was uncertain whether the strabismus was the cause or the consequence of the amblyopia. Up to very recently the view has been maintained that a congenital defect of the central retina in one eye, attended by low visual acuity, might cause the strabismus. The absence of anatomic signs, however, and the success with which the amblyopic condition can frequently be improved by use and training, have demonstrated the essentially functional nature of the defect in the great majority of cases. It now appears probable that ordinarily the amblyopia is an adaptation to strabismus which prevents diplopia by suppression of the response from one eye.†

The nature of this supression is still obscure. Some functional deterioration of the visual mechanism might be associated with disuse of one eye (hence amblyopia *ex anopsia*); or alternatively responses from the affected eye might be actively inhibited (*"Hemmungsamblyopie"*; cf. Harms, 1938). In the latter event this type of amblyopia may differ only in its relative permanence from those cases of alternating strabismus in which either eye alone is capable of a high visual acuity, while the visual acuity of the deviated eye is temporarily suppressed.

The site of the defect also is not known. The demonstration that strabismic amblyopia is curable has led many workers to assume it to be "psychic" in nature; we take this to mean that it involves the participation of the cerebral cortex. A cortical dysfunction or inhibition might confine its effects to the cortex itself, or might project them centrifugally upon lower levels of the visual pathways. Harms (1938), as the result of studies of the pupillary light reflex in normal and amblyopic eyes, has concluded that the inhibition, though originating in the cortex, is projected so as to suppress the activity of the retina itself.‡

* From the Dartmouth Eye Institute, Dartmouth Medical School, and the Biological Laboratories of Harvard University. Presented at the fourteenth scientific meeting of the Association for Research in Ophthalmology, at Chicago, June 13, 1944. This research was supported in part by a grant to one of us (G. W.) by the Josiah Macy, Jr., Foundation.

† An excellent review of this subject and its literature can be found in the paper by Harms (1938).

‡ It might be supposed that because of the semidecussation of the optic tracts and consequent central projection of corresponding areas of the two retinas upon the same side of the cortex, any cortical effect upon visual sensation should involve binocular fields. Actually, however, these anatomic arrangements do not in themselves entail sensory "fusion." Sherrington (1906, p. 354ff.) has shown that on the contrary the uniocular image retains a high degree of sensory integrity in binocular vision. The fact that strabismic amblyopia is unilateral, therefore, is not in conflict with its presumptive cortical origin. The same may be

In order to learn more about these matters, and at the suggestion of one of us (H. M. B.), we undertook an investigation of the absolute threshold of vision in amblyopic and normal eyes. All measurements reported here were performed at the Dartmouth Eye Institute in Hanover, New Hampshire.

Apparatus

The adaptometer used for measuring visual thresholds in these experiments was designed and built by one of us (G. W.) at the Biological Laboratories of Harvard University. A description of its general design and operation follows; the details of its construction will be discussed elsewhere.

The distinguishing feature of this instrument is the use of a high-pressure mercury arc as source. From its radiation nine highly monochromatic regions of the spectrum are isolated with color filters. These include lines at about 365, 405, 436, 492, 546, 578 and 623 mμ; and narrow continuous bands centered at about 690 and 760 mμ. The intensity which is delivered to the test field at each of these wave lengths is varied accurately by means of a calibrated optical wedge. The wedge alone provides a range of intensities of about six logarithmic units (about 1,000,000 times); the intensity can be still further reduced when necessary with neutral filters.

The test field is circular, and subtends a maximal visual angle of 2 degrees. Diaphragms may be placed over it to reduce its size to any desired degree. The field is exposed to the eye in flashes of constant duration, regulated with a camera shutter. In all the present experiments flashes of 0.04 second were employed.

By means of a slide built into the viewing section of the instrument either eye can be occluded at will. In the present experiments the two eyes were measured alternately, the dominant eye serving as control for the amblyopic.

A fixation point is provided which may be moved to any position within a radius of 12 degrees from the center of the test field. This was constructed from a general design invented by Abney and Watson (1916). Light is led down a very narrow glass rod to appear as a bright point at its tip. The rod is mounted in a universal ball-joint so that it can be moved freely into any desired position. By this means it is possible to fixate the eye so that the image of the test field falls on the fovea or on any region of retina within 12 degrees of it. The fixation point is illuminated continuously, and its brightness is regulated with a rheostat.

With this instrument one can measure conveniently: (a) the dark adaptation—the decrease of threshold in darkness following a preliminary exposure to light—of any desired area of retina at any available wave length; (b) the variation of threshold with location of the field on the retina, at any of the available wave lengths; and (c) the energy threshold of the retina at various wave lengths of the spectrum, in central and peripheral areas. All three types of measurement were included in the present experiments.

Observations

All the experiments reported in this paper were performed upon five patients. Their clinical histories are appended below. Two of them were male college students, 18 and 23 years of age. The others were children—two 10-year-old boys and one 11-year-old girl. One of the students (G. E. T.) could be seen repeatedly and was the subject of the most extensive series of measurements. The others were

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said of the functional scotomata which frequently accompany strabismic amblyopia and are found also in the deviated eye in cases of alternating strabismus.

available only during routine visits to the clinic, none of them more often than twice. All these patients presented typical histories of strabismic amblyopia. In all of them the corrected vision of the dominant eye was at least 20/25, whereas that of the amblyopic eye was 20/200 or less.

It should be noted that all these patients were wholly unused to procedures such as the present one. For all of them it contained novel experiences and demands: long periods spent in total darkness, the requirement that they fixate accurately a point of light, and that they simultaneously recognize a flash of light at the absolute threshold of vision, often at a considerable distance from the fixation point, and often with the added demand that they specify its color. In view of their inexperience and of the youth of three of the patients the results obtained were gratifyingly accurate and clear.

In all our experiments the threshold was measured in the two eyes alternately, the behavior of the dominant eye serving as control for that of the amblyopic eye. In every case the data obtained with the better eye agreed with those from ordinary normal observers. The most relevant datum however, under all circumstances, is the relative performance of the two eyes rather than their absolute capacities.

It should be understood that absolute thresholds measured under carefully controlled conditions in normal observers may vary more than a logarithmic unit (that is, more than by a factor of 10) from person to person, and may vary 0.3 to 0.4 logarithmic unit in the same individual from day to day. In inexperienced observers the variation encountered in the course of a single measurement is usually 0.15 to 0.25 logarithmic unit, and may be larger. Differences of less than 0.3 logarithmic unit in our measurements therefore are probably not significant unless consistently maintained, and sporadic differences even as high as 0.4 logarithmic unit need not be significant.

Dark adaptation. This was measured in a peripheral field in two patients. The subject was first highly light-adapted by exposure to a bright white light for 3 minutes. At the close of this period the light was turned off, leaving the patient in complete darkness. At periodic intervals thereafter the threshold was determined alternately in the dominant and the amblyopic eye. The minimal exposures to light which this procedure involves do not disturb the course of dark adaptation.

The results of one such experiment, performed on the student G. E. T., are shown in figure 1. The test field subtended a visual angle of 2 degrees, and was located so that its center lay 8 degrees below the fixation point; that is, so that its image fell on the retina 8 degrees above the fovea. Thresholds were measured with yellow light (578 mμ).

At the beginning of dark adaptation the threshold falls sharply, reaching a first plateau which is maintained until about the thirteenth minute. Then the threshold falls again to a second and final plateau, attained in about 35 minutes. The decline in threshold to the first plateau is known to be due to the adaptation of cones; the second segment of adaptation is due to rods.

It is clear from figure 1 that the thresholds in the light-adapted condition and throughout the entire course of dark adaptation are essentially identical in the dominant and amblyopic eyes. Data from a similar experiment with the boy, R. H. S., although not so precise as those shown in figure 1, revealed the same correspondence in the thresholds of normal and amblyopic eyes.

Threshold contours. These were measured in the completely dark-adapted eyes

of three patients. The field, which subtended a visual angle of 1 degree, was centered within the fovea and at various distances above and below it, and the threshold was determined in each position. In this way one obtained a contour of the distribution of thresholds over the retinal surface.

In the student, G. E. T., this was done at two wave lengths, in the red (690 mμ) and violet (436 mμ); in the student, T. P., the contour was measured only above the fovea and in violet light. The data obtained in these experiments are shown in figure 2. In addition, a complete contour was measured in green light (546 mμ) in the boy, G. E. C.

When located peripherally the field looks colorless, since here the threshold is due to rods, which excite only achromatic sensations. A field 1 degree in diameter, if fixated centrally with sufficient accuracy, falls entirely within the rod-free foveal area, and hence should be seen as colored. The appearance of color in this experiment is indicated in figure 2, with small letters, *r* for red, and *b* for blue, the reported color of the 436 mμ radiation. The latter color was seen only within the fovea itself; that it was seen at all in light of such low wave length and in the dark-adapted eye—both conditions which favor the stimulation of rods—is an assurance of a remarkable capacity for accurate central fixation with the amblyopic eye. Even the deep red radiation (690 mμ), which favors the stimulation of cones, was seen by G. E. T. as colored only within a radius of 1 degree of the fovea.

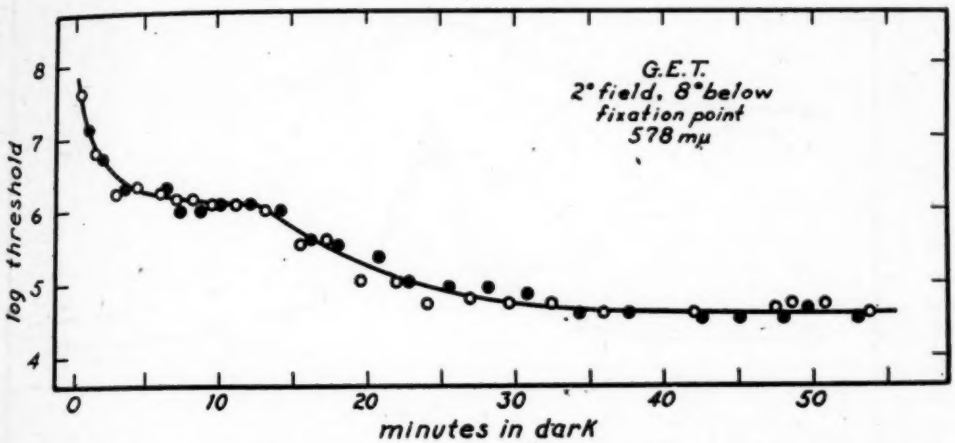

Fig. 1 (Wald and Burian). Dark adaptation following a 3-minute exposure to bright white light. The initial fall of threshold to a first plateau is due to cones, the second fall to a final minimal level is due to rods. Data from the amblyopic eye are shown with solid circles, those of the dominant eye with open circles. Thresholds are in arbitrary units of relative energy.

Characteristically such threshold contours have the bell-shaped form shown in figure 2, the threshold of the dark-adapted retina rising from the periphery toward the fovea. The central rise in threshold is particularly marked in violet light, for two reasons: the yellow pigmentation of the macular area selectively absorbs violet light; and the shift from rod to cone vision as the field moves into the fovea involves a decreased sensitivity to the violet (the Purkinje shift; cf. figure 3).

In figure 2 any tendency toward systematic deviations in threshold in the two eyes is indicated by separate curves. In red light G. E. T. displayed no such dif-

ferences peripherally or foveally. In violet light this observer's threshold in the amblyopic eye fell slightly *below* that of the dominant eye in the central region from 2 degrees above to 2 degrees below the fovea. In violet light T. P. did not show this difference centrally, but in the region 3 to 6 degrees above the fovea his amblyopic eye yielded thresholds slightly *lower* than the dominant eye. The data obtained with green light from G. E. C., not shown in the figure, displayed no consistent differences in threshold centrally or peripherally.

These results may be summarized as follows: The thresholds of the amblyopic eye, foveal and peripheral, are very close to those of the dominant eye in all cases. The small differences which have been observed are not maintained consistently from subject to subject; and to the degree that they are significant they reveal a greater sensitivity in the amblyopic eye.

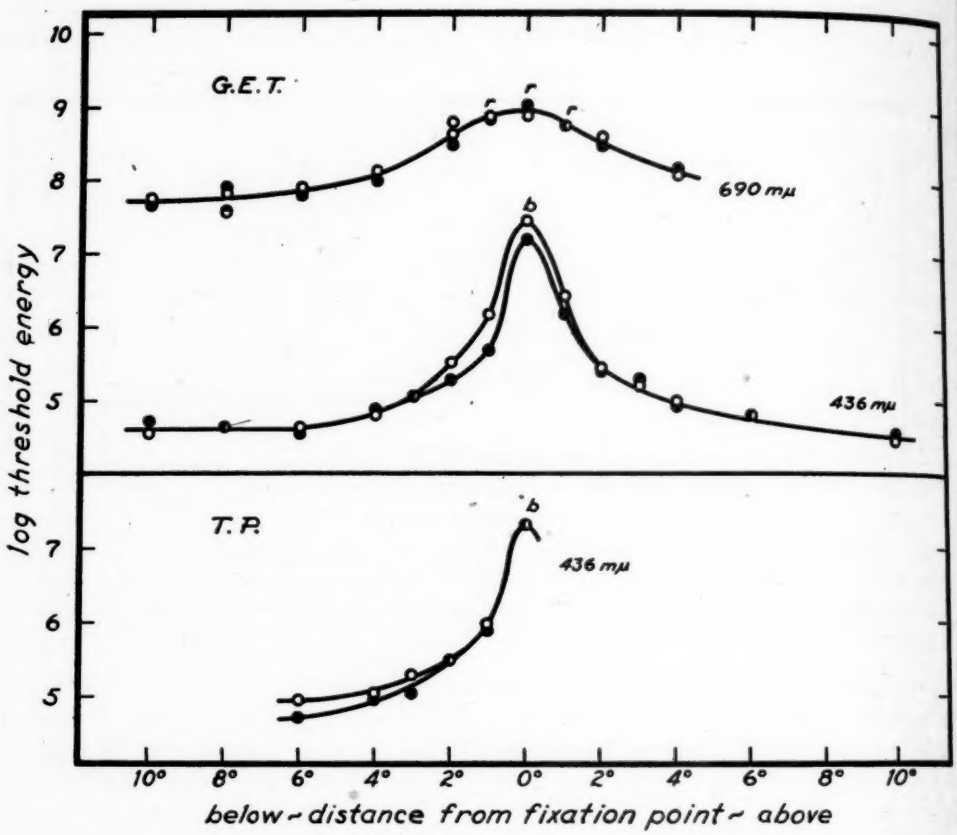

Fig. 2 (Wald and Burian). The variation of threshold with position of a 1-degree field on the retina, measured in red (690 mμ) and violet light (436 mμ) in the completely dark-adapted eye. The field appears colorless in the periphery, but colored centrally either red (r) or "blue" (b). Solid circles show data from the amblyopic, open circles those from the dominant eye.

Spectral sensitivity. The amounts of energy needed to stimulate minimal sensations of light or color vary greatly with the wave length. In a special series of experiments the thresholds of completely dark-adapted subjects were measured at a series of wave lengths, in fields of

fixed size and retinal location.

When such experiments are performed in peripheral areas of the retina, the image of the test field appears colorless regardless of the wave length. This is due to the fact that the threshold of the dark-adapted periphery is due to rods alone—even in red light, contrary to a persistent misapprehension. Fields fixated centrally may appear at the threshold as colored, an indication that cones are stimulated; or they may appear initially as colorless, showing that the stimulated area includes rods. In the latter event, after the "white" threshold has been recorded, the intensity may be raised further until the color threshold is reached. The difference between the "white" and color thresholds is the familiar "photochromatic interval." A central field is most likely to appear initially as colorless when low wave lengths are employed, since to these the rods are peculiarly sensitive.

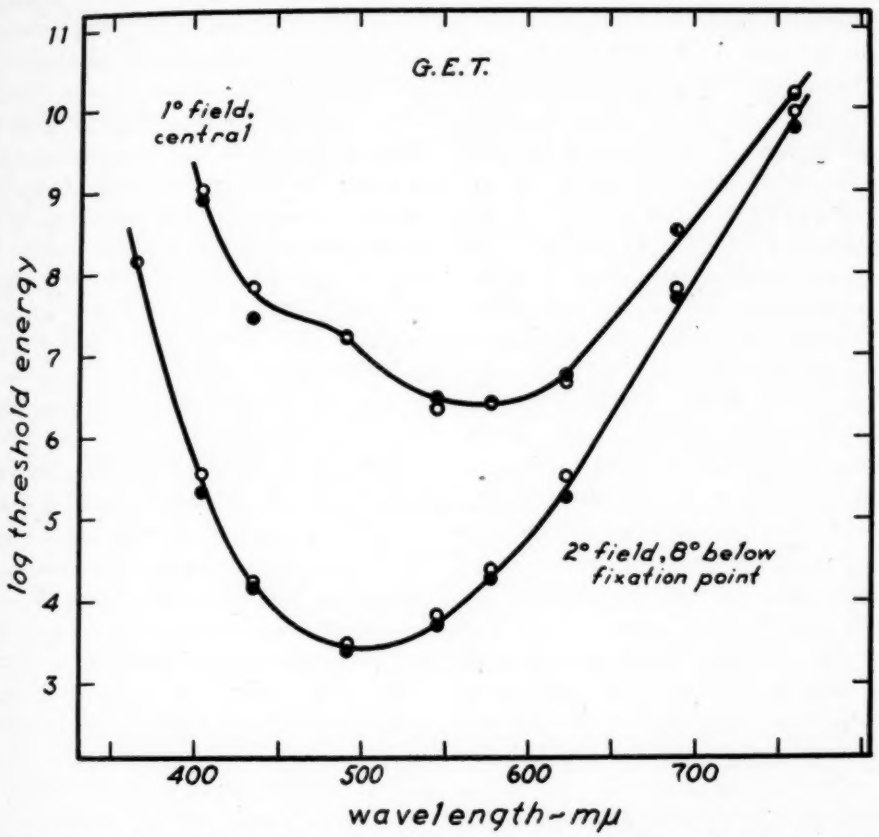

Fig. 3 (Wald and Burian). The variation of threshold with wave length in foveal and peripheral fields in a completely dark-adapted subject. All thresholds in the peripheral field were reported as colorless, all the foveal thresholds as colored. Solid circles show data from the amblyopic eye, open circles those from the dominant eye. Thresholds are in arbitrary units of relative energy.

The variation of threshold with wave length in central and peripheral fields, measured in the student G. E. T., is shown in figure 3. In a 2-degree field centered 8 degrees below the fixation point the data are typical of those obtained from rods. The threshold is minimal at

about 505 mμ, rising steeply and more or less symmetrically toward both shorter and longer wave lengths. Throughout the spectrum the thresholds of both amblyopic and normal eyes of this observer remain close together, with the threshold of the amblyopic eye consistently slightly lower except at 365 mμ, where the thresholds of both eyes are equal.

With a field 1 degree in diameter fixated centrally this observer yielded the data shown in the upper curve of figure 3. Such a field, if the fixation is sufficiently accurate, ordinarily should fall entirely within the rod-free area of the fovea, about 1.7 degrees in diameter, and thus should stimulate only cones. Actually the curve shown is a typical cone function. The threshold is minimal at about 565 mμ, the value normal for foveal cones (Fedorov, et al., 1940). The displacement of the minimum threshold toward the red as compared with the rod function is typical of the shift of sensitivity associated with the transfer from rod to cone vision (the Purkinje shift). Furthermore this observer reported correctly at the absolute threshold the colors of the field at all wave lengths. There can be little doubt that throughout this experiment the subject maintained a sufficiently accurate fixation to hold the field wholly within the rod-free area.

In this purely foveal field the thresholds of dominant and amblyopic eyes were essentially identical. What differences appeared were small and were not consistently maintained from one wave length to another. The moderate difference recorded at 436 mμ may have been significant, however, since it appeared also in the central measurements at 436 mμ from this observer, shown in figure 2.

What is perhaps most surprising in these data is their unequivocal evidence that the patient could fixate centrally with his amblyopic eye with great precision. To hold a 1-degree field entirely within the fovea in the dark-adapted eye is a feat in any untrained observer; that this could be done with an amblyopic eye was wholly unexpected.

The spectral sensitivity in a 1-degree field fixated centrally was measured also in T. P. The data are shown in figure 4. In this instance the result obtained in the amblyopic eye differs in a consistent way from that in the dominant eye. In the latter case the curve is typically cone in form and position, the threshold minimal at about 565 mμ. In the amblyopic eye the curve is of about the same shape, but is displaced toward shorter wave lengths, so that the minimum threshold lies at about 545 mμ. The net effect of this displacement is that below about 565 mμ the thresholds in the amblyopic eye are lower, above 565 mμ they are higher than those of the normal eye.

This shift of sensitivity is as though the stimulated area in the amblyopic eye included a number of rods, as it might have done were fixation not sufficiently precise to hold the field within the rod-free area. A number of attendant circumstances support this interpretation of the data. This subject in general reported color sensations only rarely; it is significant that in the present instance he reported seeing the threshold stimulus at 436 mμ as "blue" with the dominant eye, as colorless with the amblyopic. The same observer, in the experiment shown in figure 2, saw a 1-degree central field as blue at about the same intensity with both eyes; actually in this case also, however, he had reported seeing the field as colorless in the amblyopic eye about 0.5 logarithmic unit lower than the color threshold. At the time the measurements shown in figure 4 were performed, this subject complained of difficulty in fixating with the amblyopic eye, saying that he felt that this eye tended to wander off

the fixation point. It is important to note, however, that the central data from the amblyopic eye are still overwhelmingly of the cone type, as comparison with the peripheral (rod) data of figure 3 shows. We should conclude, therefore, that even this patient displayed a remarkable capacity for central fixation with the amblyopic eye, though not as precise as that of his normal eye, or as either eye of G. E. T.

In three patients the spectral sensitivity was measured in a field 2 degrees in diameter, fixated centrally. The data are shown in table 1. Such a field could possibly be contained wholly within the fovea in certain instances, but ordinarily it projects beyond this at its boundaries and includes a few rods. For this reason the field is usually seen at the threshold as colorless, particularly at shorter wave lengths, and the intensity must be raised further to reach the color threshold. Both "white" and color thresholds are shown in the table.

In G. E. T. the thresholds of the amblyopic eye at low wave lengths tend to lie slightly below, those at long wave lengths slightly above those in the dominant eye. These differences are comparable in trend with those shown in figure 4. In R. S. no significant differences appear between the two eyes throughout the spectrum. In I. M. the thresholds in the amblyopic eye lie consistently about 0.4 logarithmic unit below those in the dominant eye. The averaged results for these subjects reveal a tendency of the thresholds in the amblyopic eye to fall below those of the dominant eye, marked at short wave lengths, probably insignificant at long

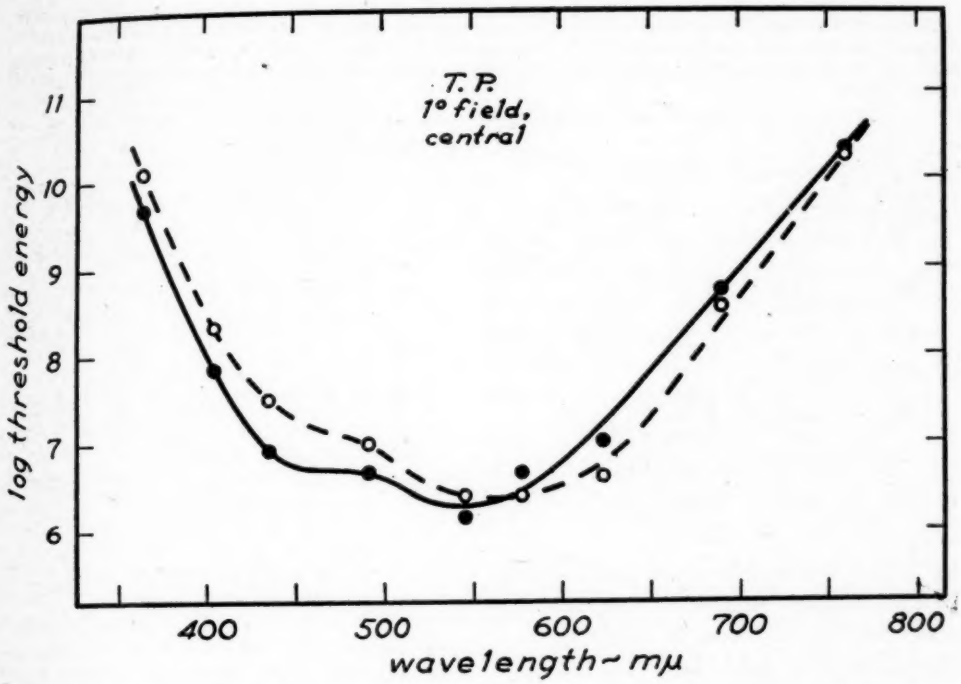

Fig. 4 (Wald and Burian). The variation of threshold with wave length in a 1-degree field fixated centrally, in the subject T. P. The solid line and solid circles show data from the amblyopic eye; the broken line and open circles show measurements from the dominant eye.

wave lengths. The differences are relatively small in all cases. They probably mean—in the subjects G. E. T. and I. M.—a greater participation of rods in the thresholds of the amblyopic eye, due to less perfect central fixation. In R. S., in whom these differences did not appear, a marked fixation nystagmus was observed in both eyes; it might be concluded that for this reason central fixation in both eyes was equally imperfect. It is curious, however, that this patient reported the color correctly at the absolute threshold in both eyes at all wave lengths but 405 mμ, at which he saw the field as colorless slightly below the color threshold (cf. table 1).

A small superiority in fixation by the dominant eye being in general conceded, it must be stressed that this is not always evident, and that in any case fixation by the amblyopic eye in view of its low visual acuity is amazingly good.* It is clear also from these measurements that both cone and rod apparatuses are intact in the amblyopic eye; and that the sensitivity of its fovea is not consistently inferior to that of the dominant fovea of the same subject.

TABLE 1

THRESHOLDS OF AMBLYOPIC AND DOMINANT EYES OF THREE SUBJECTS, MEASURED AT VARIOUS WAVE LENGTHS IN A FIELD 2 DEGREES IN DIAMETER, FIXATED CENTRALLY. AT LOW WAVE LENGTHS SUBJECTS USUALLY REPORT THE FIELD INITIALLY AS COLORLESS ("WHITE"); THE INTENSITY MUST BE RAISED FURTHER TO REACH THE COLOR THRESHOLD. THRESHOLDS ARE EXPRESSED AS LOGARITHM OF THE RELATIVE ENERGY.

Wave length (mμ)	Type of Threshold	Log Threshold Energy							
		G. E. T. Age 18		R. S. Age 10		I. M. Age 11		* Averages	
		Ambly.	Dom.	Ambly.	Dom.	Ambly.	Dom.	Ambly.	Dom.
365	white	10.30	10.21	—	—	10.02	10.40	10.16	10.30
	color	10.91	11.10	10.27	10.34	10.21	10.57	10.45	10.67
405	white	7.67	8.00	7.59	7.52	7.11	7.51	7.46	7.68
	color	7.86	8.12	7.75	7.60	7.27	7.68	7.63	7.80
436	white	—	—	—	—	5.97	6.33	—	—
	color	6.63	7.05	6.63	6.63	6.17	6.53	6.48	6.77
546	white	5.60	5.65	—	—	5.48	5.88	5.54	5.77
	color	6.00	6.01	5.72	5.55	—	—	5.86	5.78
578	white	—	—	—	—	5.98	6.19	—	—
	color	5.85	5.69	6.17	6.13	6.06	6.34	6.03	6.05
623	color	6.01	5.93	6.25	6.17	6.09	6.66	6.12	6.25

CLINICAL REPORTS

R. H. S., white boy, 10 years old. The left eye had turned in ever since the first year of life. When first seen at the age of three years, the patient had a convergent strabismus of the left eye of 70Δ. The visual acuity of the left eye had always been extremely low and was not materially improved by occlusion. The angle of squint had been reduced by operative procedures to 4 to 5Δ. Visual acuity, with correction: R.E. (+2.50D. sph. ⊂ +1.50D. cyl. ax. 80°) = 20/25–2; L.E. (+2.00D. sph. ⊂ +0.75D. cyl. ax. 100°) = 10/200, eccentric fixation.

T. P., white male, 23 years old. The right eye used to turn in when the patient was a child; it straightened spontaneously. Visual acuity: without correction, R.E. 20/400; L.E. 20/400; with correction, R.E. (−0.50D. sph. ⊂ −0.25D. cyl. ax. 30°) = 20/400+1; L.E. (−1.75D. sph.) = 20/12. There is a convergent strabismus of 10Δ with normal retinal correspondence in the afterimage test and on the synoptophore. The patient has fusional amplitudes, but cannot bar-read.

* It is significant that when the fixation star was presented alternately to the two eyes, none of the patients observed any appreciable difference in its appearance.

G. E. C., Jr., white boy, 10 years old. Turning in of the left eye was noticed by parents one year prior to examination. Visual acuity: without correction, R.E. 20/20; L.E. 20/200; with correction, R.E. (+1.25D. sph. ⊂⊃ +0.50D. cyl. ax. 90°) = 20/20; L.E. (+0.50D. sph. ⊂⊃ +1.00D. cyl. ax. 90°) = 20/200+1, fixation uncertain. There is a convergent strabismus of the left eye of 15$^{\Delta}$. The amblyopia prevents exact determination of the sensorial retinal relationship.

G. E. T., Jr., white male, 18 years old. Turning in of the right eye had been noticed since the patient's second year of life. He has worn glasses since the age of five years. At the age of 10 years he had orthoptic treatment for 18 months. Visual acuity: without correction, R.E. 20/200; L.E. 20/20+2; with correction, R.E. (+3.00D. sph. ⊂⊃ +0.75D. cyl. ax. 100°) = 20/200+1; L.E. (+3.00D. sph. ⊂⊃ +0.25D. cyl. ax. 135°) = 20/15. There is, with correction, a convergent strabismus of the right eye of 15 degrees with anomalous correspondence in the afterimage test.

I. M., white girl, 11 years old. No cross-eyedness noticed by parents. Poor vision in right eye discovered by school nurse. Visual acuity: without correction, R.E. 20/400; L.E. 20/20; with correction, R.E. (+7.50D. sph.) = 20/200, fixation uncertain; L.E. (+5.00D. sph. ⊂⊃ +0.75D. cyl. ax. 135°) = 20/20. There is a convergent strabismus of the right eye of 12$^{\Delta}$, with 2$^{\Delta}$ of right hypertropia. Retinal correspondence normal on the synoptophore; the patient has fusional amplitudes. After total occlusion of the left eye for one month following the tests, the corrected visual acuity improved only to 20/200+1, but the fixation was much better and steadier and the patient reported considerable subjective improvement.

Discussion

The results of our experiments may be summarized as follows: In the instances of strabismic amblyopia that we have examined the absolute threshold was normal, foveally and peripherally, in cones and rods, and in light and dark adaptation. It must be concluded that the entire apparatus of simple light perception is normal in these subjects. With this was associated a capacity approaching normal for fixating and localizing illuminated points and areas on the central and peripheral retina.

More extensive examination of this class of patients may reveal that some of them react differently from what is here described. This should not detract materially from the conclusions which we wish to draw. Yet it should be noted that all our subjects presented exemplary cases of the defect under consideration, and responded uniformly to our procedures. For these reasons it may be hoped that the results of our experiments and our conclusions from them are generally valid.

That the capacity for pattern discrimination may fall as low as 20/200 to 20/400 without any loss of sensitivity to light shows that in man the apparatus for form vision is to some degree distinct from that involved in simple light perception. This inference is consistent with the results of recent investigations of central structures concerned in vision.

It has recently been shown that in rats (Lashley, 1931), dogs (Pavlov, 1927, p. 341; Marquis, 1934), cats (Smith, 1937), and monkeys (Klüver, 1941, 1942; Marquis and Hilgard, 1937), complete removal of the occipital lobes of the cerebral cortex results in virtually complete loss of pattern and object vision, with little if any observable loss in the capacity to react to light or discriminate brightnesses.* Such animals also may retain a capacity to localize stimuli within the visual field sufficiently good to be of important use in orienting the animal's movements. These experiments show that in mammals generally the anatomic structures associated with simple light discrimination and some degree of visual spatial orientation are subcortical, whereas pattern and object vision require the services of the occipital cortex. The animal deprived of its visual cortex ex-

* Excellent reviews of this subject have been written by Marquis (1934) and more recently by Fulton (1943) with Marquis's collaboration.

hibits in extreme form properties which resemble to a remarkable degree those found in the amblyopic vision of our patients.

It has been reported that in man complete destruction of the occipital lobes results in complete and permanent blindness, and the loss of all sensations to light (Marquis, 1934). Apparently in man all sensory aspects of vision possess indispensable cortical components. Perhaps this may be viewed as a final stage in the phylogenetic "encephalization" of visual functions (cf. Marquis, 1935). Our experiments show, however, that in man also, since pattern vision can be so completely separated functionally from light perception and spatial projection, these functions must maintain some degree of anatomic separation.* One may suppose further that within this sensory hierarchy, pattern vision, as in lower mammals, continues to occupy the higher level.

These considerations lead to the following conception of the nature of strabismic amblyopia. It appears to consist in a cortical inhibition of the higher cortical function of pattern vision, without notable impairment of the lower cortical functions of simple light perception and spatial localization. If, as we and others have supposed, the object of the amblyopia is to prevent diplopia in strabismus, this is accomplished with the maximum economy. Only the disturbing image is suppressed, without interfering with irrelevant visual functions or structures.

The localization of the primary defect in strabismic amblyopia in the cerebral cortex places it in that organ of the nervous system primarily concerned with the formation of new adaptive responses. We have in this consideration some physiological sanction for the cure of such amblyopias through use and training, and support for the belief that the defect itself arises as an adaptation to strabismus, imposed upon an originally normal visual apparatus.

This conception of strabismic amblyopia differs in important ways from that proposed recently by Harms (1938). This investigator had measured the pupillomotor sensitivity of the retinal center and periphery in normal and amblyopic eyes. In the normal retina the center is more effective than the periphery in closing the pupil. In amblyopic eyes Harms found the central sensitivity to be relatively decreased. He concluded that the defect in strabismic amblyopia must be located below the point at which the pupillary pathways depart from the visual projection, a consideration which he believed restricted it to the optic tract, optic nerve, and retina. He decided that it must, in fact, lie in the retina. Though agreeing that the inhibitory process originates in the cerebral cortex, Harms concluded that it is projected centrifugally so as to suppress the activity of the retina itself.

Apart from the fact that no mechanism for cortical inhibition of retinal function has yet been demonstrated, it is difficult to imagine what form it could take that is not excluded by the present experiments. We have shown that retinal sensitivity is not directly decreased in strabismic amblyopia. An alternative possibility—that the activity of some elements is entirely suppressed while others continue to function normally—would explain the low visual acuity that is observed; but this also cannot be the case, since it is well known that any diminution in the number of elements stimulated—as by decrease in the size of a test field—raises the threshold to light (cf. Wald,

* Riddoch (1917) has discussed the dissociation of perceptions of light, form, and movement in the visual field, in cases of human occipital injury.

1937-1938). For these reasons the conclusion of Harms that in strabismic amblyopia retinal function is inhibited must be rejected.

Harms's observations are open to a simpler interpretation. Cortical centers are now known to exist for both dilation and constriction of the pupil (Parsons, 1901; Wang et al., 1931). It is therefore not necessary to assume an intermediate inhibition of retinal function to explain Harms's results. It may be supposed, instead, that the cortical inhibition in strabismic amblyopia is not confined to visual acuity, but extends further to include cortical pupillo-motor centers. Harms's observations indicate, however, that the pupillo-motor inhibition principally involves the projection of the *macular* region of the retina upon the cortex.

There is reason to suspect that the macular projection may be principally involved also in the inhibition of visual acuity. The residual visual acuity of the amblyopic eye is comparable with that found normally in the retinal periphery. Visual acuities of 20/200 to 20/400, such as our patients exhibited, are observed in normal eyes in areas 20 to 40 degrees from the fixation point (Wertheim, 1894). It is certainly the macular apparatus that principally loses visual acuity in amblyopia. The relative effects of strabismic amblyopia upon central and peripheral visual acuity need to be carefully examined.

A selective inhibition of the macular projection would affect pattern vision principally in bright light, and might leave it almost unchanged in dim illuminations. Some such effect might explain the extraordinary capacities of the amblyopic eyes of our subjects in the dark room as compared with their behavior on clinical examination in ordinary light. In the latter case one patient (R. S.) was unable to maintain central fixation with either eye; in all the other patients fixation with the amblyopic eye was observably unsteady. Yet amblyopic and dominant eyes behaved so similarly in our experimental procedures that had we not been aware of the histories of these patients, nothing in the course of the measurements would have suggested that their eyes differed in capacity. The possibility therefore that the amblyopia might be particularly associated with vision in bright light also requires critical examination.

It is curious that this possibility has arisen also in connection with animals from which the visual cortex had been removed bilaterally.* Smith (1937) has reported that cats in this condition fail to learn an intensity discrimination habit in bright surroundings although able to learn the same habit easily when the surrounding illumination is reduced. Klüver (1942) found that monkeys lacking the occipital cortex respond to a single light or differentiate two lights only if the over-all illumination is low or the intensity of the stimuli is very high. Poppelreuter (1923) has reported furthermore, that following occipital injuries due to gunshot wounds in man, and in hemianopias associated with central nervous diseases, patients may be entirely blind in the affected regions in bright light, yet always exhibit "amorphous" reactions to light in the dark room.

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* The extraordinary fidelity with which strabismic amblyopia mimics the condition found in animals deprived of the visual cortex may be judged from the remarks of Lashley (1931) concerning his observations on rats following this operation: "The defects of vision may be interpreted either in terms of an amblyopia with dim vision retained throughout with normal vision in the peripheral field. The visual field or an extensive central scotoma little evidence available seems to favor the former interpretation."

Summary

1. The absolute threshold of vision has been measured under various circumstances in five patients with strabismic amblyopia. In all cases thresholds were determined alternately in the amblyopic and dominant eyes. Three types of measurement were performed: (a) dark adaptation following a high state of light adaptation; (b) the distribution of thresholds over the retinal surface, central and peripheral, in the dark-adapted eye; and (c) the variation of threshold with wave length, centrally and peripherally, in the dark-adapted eye.

2. In all cases the threshold of the amblyopic eye was found to be essentially normal, foveally and peripherally, in cones and rods, and in light and dark adaptation. With this is associated a capacity approaching normal for fixating and localizing illuminated points and areas on the central and peripheral retina.

3. The entire apparatus of simple light perception and spatial localization within the visual field is therefore virtually normal in these patients. Since, however, the visual acuities of their amblyopic eyes were in no case higher than 20/200, the apparatus of pattern vision must be to some degree distinct from that which mediates the other visual functions.

4. Subhuman mammals which have been deprived of the occipital lobes of the cerebral cortex, which contain the visual areas, also lose virtually all capacity for pattern vision while retaining sensitivity to light, brightness discrimination, and visual-space localization. Pattern vision in mammals generally, therefore, requires the cortex, while other visual functions appear to be in large measure subcortical. In man there is evidence that all sensory aspects of vision have indispensable cortical components. Our experiments, however, show that here also some degree of anatomic dissociation of visual functions must exist.

5. In view of these relationships, and of the demonstrated effectiveness of use and training in curing some cases of strabismic amblyopia, it is concluded that this disability consists in a cortical inhibition of the higher cortical function of pattern vision without notable impairment of the lower cortical functions of light perception and spatial projection.

6. The possibility exists that this inhibition involves principally the macular projection on the cortex and, perhaps as a consequence of this, pattern vision primarily in bright light.

Biological Laboratories of Harvard University.

The Dartmouth Eye Institute.

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Discussion

Dr. Sloan: Would this explain improvement in light threshold *without* improvement in form vision in recovery from vitamin-A deficiency?

Dr. Burian: No, I do not believe so.

Dr. Sloan: May I explain why I asked the question? We have had such cases. About six men were referred because they had difficulty in night flying. There were evidences that they had been on poor diets. They were returned to a normal vitamin-A diet, and the light threshold recovered before form perception in low illumination.

Dr. Burian: The improvement in the light threshold by vitamin-A therapy is a peripheral process; we believe the dissociation of light perception and form vision in our amblyopia patients to be of central origin. May I add that our assumption is strengthened by clinical experience gathered during the last war in England, France, and Germany. Patients who had sustained gunshot wounds to the occipital lobes, in recovering sight first regained light perception. Qualitative light perception was the first degree of restitution before any form vision was reacquired.

Dr. Clapp: Please comment on the efficiency of light-flashing orthoptic apparatus in amblyopia ex anopsia.

The Chairman: It seems to me that that is a little outside the province of this paper.

Dr. Burian: It is, and I have had no personal experience with it. It is, however, conceivable that better fixation may be obtained in amblyopic eyes when light is presented in short flashes.

THE HISTORY AND DEVELOPMENT OF THE IRIS-INCLUSION OPERATIONS*

THOMAS D. ALLEN, M.D.
Chicago

It was quite obvious to Sir William Adams in 1812 that some better method of treating painful eye disorders was necessary than the usual routine in vogue in his time. Ten years earlier, in 1802, according to J. V. Solomon,[1] writing in 1863, Dr. Whyte[2] had recommended a section of the ciliary region for the relief of pain. He is quoted as follows:

"In cases of enlargement of the anterior hemispheres of the eye . . . puncturing the eyeball with a couching needle. His incision was made through the sclerotica into the posterior aqueous chamber, the instrument being carried 'behind and parallel to the iris.' He directs 'the outlet' (incision) should be 'proportioned to the existent expansion' . . . ."

Solomon goes on to say that in 1807 Mr. Wardrop in the Edinburgh Medical and Surgical Journal (volume III) wrote on the "Relief of inflammation of the eye by opening the cornea and evacuating the aqueous humour," and in 1813 presented a paper in London before the Medico-Chirurgical Society:[3] "On the effects of evacuating the aqueous humour in inflammation of the eyes and some diseases of the cornea," in which he refers to the great and immediate relief of his patients on the sudden removal of tension.

Naturally these operative measures were not always followed by happy results; surgeons became fearful of such brutal attacks on so delicate an organ. Adams studied enucleated eyes and finally wrote a "Treatise on artificial pupil,"[4] in which is described a series of improved operations that he and his disciples had used from 1812 to 1819 and had called *iridencleisis*.

One of his pupils, Karl Himly,[5] in 1816 quoted Adams as noting that the prevalent method of treating eye diseases "by blood letting to the point of fainting and extreme weakness" often left the patient in a dire condition for years. He therefore sought to treat the eye itself by less drastic means whenever possible. Among other observations, he noted that certain patients could not see if their pupils were occluded by inflammatory exudate; and after the acute inflammatory signs had abated he would try to make new pupils for them by incising the cornea, allowing the aqueous to escape and then drawing a portion of the iris outside of the aqueous chamber and usually excising the prolapse. In such cases the cornea would often become less cloudy, there was return of the sight and there was relief from pain and headache as soon as the pain from the operation itself passed. He also would rub the inflamed eye through the upper or lower eyelid with his finger, in spite of the risk involved. These procedures he taught to others, among whom was Karl Himly, who continued to practice them and to write about them in Germany.

The middle of the 19th century saw men like Bowman working in England, Graefe in Germany, Donders in Holland. Each in his own way was working out his clinical problems; each had associates. One of Bowman's associates was George Critchett who became a great London ophthalmologist. At the age of 30 years he wrote a paper[6] on "Iridesis: or the formation of artificial pupil by tying the iris."

The operation is performed in the fol-

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* Presented at the Chicago Ophthalmological Society, November 15, 1943.

lowing manner: "A wire speculum is inserted, and with a pair of forceps a small fold of the conjunctiva close to the cornea is held so as to fix the eye. An opening is then made with a broad needle through the margin of the cornea, close to the sclerotic, and just of sufficient size to admit the cannula forceps: with it a small portion of the iris, near, but not close to, its ciliary attachment, is seized and drawn out to the extent considered necessary to enlarge the pupil; a piece of fine floss silk, previously tied in a small loop around the cannula forceps, is slipped down and carefully tightened around the portion of iris made to prolapse, so as to include and strangulate it. This maneuvre requires a little practice and dexterity and is best accomplished by holding each end of the silk with a pair of small forceps with broad extremities, bringing them exactly to the place where the knot is to be tied, and then drawing it moderately tight. A single tie is sufficient; the ends are then cut off and the operation is complete. Little or no irritation usually follows. The small portion of iris included in the ligature speedily shrinks, leaving the loop of silk, which may be removed from the eye about the second day. This operation has been performed many times by myself and my colleagues, Mr. Bowman and Mr. Poland, and the result has been in every respect most satisfactory."

In volume II is found an addendum: "Further remarks on the formation of artificial pupil by iridesis." In this article[7] the writer describes some changes he has made in his technique and also gives some cases illustrative of the various "morbid" conditions to which it is suited. "I believe that it (iridesis) possesses important advantages over every method hitherto proposed . . . and I confidently anticipate its very general adoption."

It is interesting to note some remarks that this same George Critchett made on June 9, 1882, just five months before his death. At the time he was vice-president of the British Ophthalmological Society.[8] In discussing a paper on sclerectomy he made it very evident that he disapproved the inclusion of iris in a scleral wound, on account of the danger of sympathetic ophthalmia: "I am careful always to divide the corneosclerotic tissue just in front of the ciliary body and to leave a small bridle of this tissue undivided. If a slight prolapse of the iris occur at either corner, I endeavor to remove it." A recent remark on the Critchett operation was made by Samuel Theobald[9] of Baltimore, in discussing Harrower's contribution (vide below): "The operation was done where there was a central corneal opacity, the idea being to obtain a narrow pupil with apex at the margin of the cornea. An incision having been made in the corneo-scleral junction with a broad needle, the iris was seized at the pupillary margin with a blunt hook, drawn out, and about it was tied a fine silk loop. The included portion sloughed and the iris became adherent to the corneal wound. The immediate result was satisfactory but the operation was eventually abandoned because, every now and then, a case of sympathetic ophthalmitis resulted."

While this was going on in England, Von Graefe was writing his monographs on iridectomy in iritis, choroiditis, and glaucoma. In 1857 he introduced iridectomy[10] as the best operation for glaucoma, and specified three cardinal principles of technique: (1) Make the incision enter the extreme periphery of the chamber. (2) Make the incision as broad as possible. (3) Tear the iris from the root.

He believed the operation opened up the natural channels of outlet for the aqueous.

To appreciate the situation in Von Graefe's time we should recall that ophthalmology was just emerging from the dark ages. Although a method of examining the interior of the eye by reflected light had been expounded by Helmholtz in 1851, glaucoma was not the entity nor symptom complex that we know today. The importance of hardness of the eye was just being appreciated, and the degree of hardness was measured by the fingers as +1, +2, +3, and stony hard. When hardness was associated with hyperemia and pain, it was an acutely "inflammatory" eye for which the patient would insist on some relief even if it meant removal of the eye. The only medical measures at hand were the opiates. Opening the cornea to let out the aqueous would give only temporary relief without much chance of saving the sight. So it was a great boon to humanity when Graefe found that by using a limbal incision and by removing the iris tissue, the pain could be relieved, the globe could be retained and often some sight as well. Physicians knew well the danger of opiates then as they do now, and undoubtedly sought to perform the operation with the least opiate. But the less opiate, the less toilet of the wound was possible, for the tissues were exquisitely tender. Chloroform was often used for general anesthesia; we all know how postanesthetic retching and vomiting often disturb a perfect wound toilet. Undoubtedly many an eye was therefore left without a proper toilet of the wound; that is, portions of the iris torn from its root in the ciliary body were probably left in the wound. This fact undoubtedly worried many an eye surgeon, because for years it had been known that an eye injury followed by incarceration of uvea in a corneal or scleral wound often resulted in sympathetic ophthalmia and blindness in both eyes. But untreated glaucoma also resulted in blindness, and when glaucoma caused blindness in one eye, it was apt to be followed by glaucomatous blindness in the other eye.

I have tried to show in the foregoing that there was an attempt by the ophthalmologists to break out of their bonds of ignorance. They would catch an idea, but, handicapped by their training and their lack of the scientific approach, they did not seem to be able to follow their ideas logically. Von Graefe brought a new viewpoint and stimulated many others to similar thoughtful consideration of clinical pathology, symptoms, diagnosis, and treatment. One of the first young men to react to his monograph on glaucoma was Coccius.

E. A. Coccius[11] noted in his thesis in 1859 that the iridectomy of von Graefe and the paracentesis operation were often only temporarily successful; the disorder often passed into a chronic stage characterized by progressive destruction of the optic nerve and blindness associated with recurrent and often continuous increase in tension. Coccius modestly announced: "We have had the good fortune to discover a new method of operating for chronic glaucoma. . . . It consists in this: in the iridectomy only a small part of the iris is cut off, the other part is left lying in the wound, so that the iridectomy is combined with an iridencleisis. . . . The iridencleisis may cause emphatically dangerous accidents but there is a decided difference here: whether a large piece of the iris shall be enclosed in a small wound (after which the well-known incarceration phenomena may appear); or whether a small piece of the iris shall be left lying in a large wound. In the latter case we have not observed inflammation; but the results for chronic glaucoma are of the kind to which no other method leads us; and we have also given up many drainage procedures which we thought necessary

(even so many as 30 in different spaces of time), when in spite of the foregoing iridectomy the glaucoma made further advances. We cannot overlook the fact that we have had favorable results with these methods. . . ."

Coccius's conclusion was: "The results of iridectomy cannot be compared with those yielded by iridencleisis; the main point is not to cut out a large piece of the iris but only to let a large flap of the iris be included in the incision. . . . Then this piece of iris can drain the aqueous to a larger degree than in any other possible way through the cornea."

The question at the time was not operation or medical treatment, as the value of miotics was not discovered until nearly 20 years later—that is, eserine, by L. Laqueur (1876), and pilocarpine by A. Weber (1877), although von Graefe had found the extract of calabar bean (physostigmine) useful.

Probably the next contribution that should be mentioned is that by deWecker, who, from 1867 on, wrote voluminously on many topics in ophthalmology, and in particular regarding drainage operations for glaucoma. His microscopic studies of glaucomatous eyes, many of which had been iridectomized, led him to believe that the reason why the operation was sometimes successful was that it produced fine filtering channels which drain away the aqueous that cannot escape through the spaces of Fontana. DeWecker reasoned that these drainage channels would connect the chamber with the veins, and if there were enough of them (about one fourth the corneal circumference), the tension would recede. At first he taught that *the iris should not be touched*. Later he modified his technique to include iridectomy of the root, so the iris would not cling to the posterior surface of the cornea and block the angle.

Litton Forbes[12] in 1879 translated deWecker's "Ocular therapeutics." A few interesting quotations follow: "Glaucoma is 'the expression of a disturbance of equilibrium between secretion and excretion, with increase in the contents of the eye, and increased tension.' " On page 260, "It is now more than ten years since I insisted on the fact that the cure of glaucoma must be searched for in the reëstablishment of filtrations through a suitable cicatrix. . . . I was the first to adopt the doctrine of impaired filtration." On page 266, "Congestion, where an eye is affected by senile changes and where channels of filtration are scarcely adequate to carry off the normal accumulation of fluid, will cause an increase in tension which, though slight, will be quite sufficient to establish the vicious circle I have already spoken of." On page 270 deWecker says that he neglects his own precepts in advising removal of the iris, but this is to obtain better drainage, free of complicating iris tissue. "In this operation, iridectomy is but a mere affair of cleansing the wounds in the capsule and cornea and especially in the iridic angle—the operation establishes between the veins and the anterior chamber a more direct mode of communication." A patient upon whom a drainage operation had been performed had found that whenever the eye became irritable and hard, by pressing upon it he could relieve the irritation and cause the eye to become softer; moreover as a result of this pressure, there was an edema of the conjunctiva (page 272). . . . Miotics had been introduced in 1876 and 1877 and deWecker at once made use of them, both preoperatively and postoperatively.

At the International Medical Congress in London 1881, Mr. C. Bader[13] presented a very short contribution and showed five illustrative cases under the title, "Sclerotomy in glaucoma." "In bringing before you the following cases

of glaucoma treated by sclerotomy, I wish to prove: (1) That the kinds of glaucoma usually treated by iridectomy can be treated more successfully by sclerotomy. (2) That to secure success, it is desirable to obtain, and to maintain, a staphyloma of the conjunctiva with or without a prolapse of the iris. These cases also show the truth of the second proposition, that is, the desirability of a staphyloma of the conjunctiva, with or without prolapse of the iris. I know of no better method to secure this than the kind of staphyloma by which a small scleral flap is made, close to the insertion of the iris, leaving part of the conjunctiva adjoining the scleral wound undivided. I consider the occurrence of prolapse of the iris a favorable accident, and the non-occurrence of staphyloma as an unfavorable symptom. All steps of the operation and of the after-treatment must tend to secure a bulging of the conjunctiva, or of conjunctiva and iris, as a safety valve to too high tension of the eye ball."

During the next 20 years there was, apparently, very little to interest us, in this connection. However, various seton operations were proposed. For example: At the VIII International Ophthalmological Congress (1894), H. Walker[14] read a paper which may be summarized as follows: After so many failures in curing glaucoma by iridectomy, he tried seton operations, using various substances, including muscle tissue, passing them into or through the anterior chamber.

In the spring of 1890, Walker succeeded in making a permanent fistula by means of inserting a flap of conjunctiva into an incision in the base of the anterior chamber. A tongue flap is dissected one-sixteenth inch by three-sixteenth inch with hinge near the limbus. Near the hinge an incision is made through the cornea, perpendicular to the plane of the iris. When the aqueous has been evacuated, the conjunctival flap is pushed into the eye. The raw surface of conjunctiva will unite with the one raw edge of the corneal wound. The epithelial surface will not unite with the other edge of the corneal wound. Thus a fistula will be formed. The corneal incision must not be too large. Often the seton will have to be replaced on several postoperative days. The fistula may require occasional subsequent probing.

At the same congress (1894) Louis deWecker[15] read a paper on "Simple and combined sclerotomy." In 1867, the author says, he stated that the value of the iridectomy for glaucoma was in the section of the sclera, the iridectomy itself being of secondary importance. In 1894, M. Kvies, at the Congress in Heidelberg (p. 118 of the report), stated: "Iridectomy is chiefly performed in order to prevent the prolapse of the iris, as adhesions forming between it and the cicatrix render the usefulness of the section questionable." Knies quoted Mauthner and Snellen as having abandoned iridectomy in favor of sclerectomy; also Bader, as encouraging prolapse of the iris in the scleral wound. "The ideal operation in glaucoma is evidently a large scleral incision combined with iridodialysis, running the whole length of the cicatrix formed in the trabecular pericorneal tissue." The idea of iridodialysis seems to date from 1787, when it was performed by Assolini. In Jungken's "Ophthalmic surgery" (1829) are found descriptions of no less than 19 different methods of performing iridodialysis.

A great forward step was taken at the turn of the century. Maj. H. Herbert[16] writing on "Subconjunctival fistula formation in the treatment of primary chronic glaucoma," said that this was a report of work done in Bombay, India, and he did not lay claim to originality. Practically all patients there are seen in the late stages of the disease. Iridectomy fails or destroys vision through compli-

cations. A large classical iridectomy in advanced glaucoma is apt to be complicated by loss of vitreous, expulsion of the lens, and retinal hemorrhage. More general success was found when by accident the iris healed in the wound, especially if covered by conjunctiva. Herbert therefore purposefully attempted in 130 eyes to make a small uveal prolapse under the conjunctiva, using a thin cataract knife. Some iris was removed in 8 of these only, in the other 122, the iris remained uncut. Results:

(1) Late infection, possibly one; two eyes were lost by bacterial invasion at time of operation.

(2) Relief of tension provided by a fistulous cicatrix appeared to be certain and permanent. In no single case had there been any question of a return to hypertension after free filtration had once become established. In a few eyes the immediate lowering of tension was followed by a period of slight hypertension lasting up to two to three months; in these eyes daily massage and occasional eserine did much to control the high tension and shorten its duration. There was little doubt that one should always combine a small iridectomy with the operation, in order to obtain what relief one could by the more recognized proceeding and to rely upon the weak scar only as a sort of safety valve. Especially should iridectomy be done if there is iris atrophy. "When it has become fibrous, tough, and inelastic, it much less readily undergoes the absorption necessary to admit of the passage of aqueous through it." Some eyes became quite soft, especially if the previous tension had been quite high. Probably this was due to atrophy of the ciliary body.

(3) Effect on vision was more favorable than could be expected of simple iridectomy. Herbert says, "I have not found the operation was liable to harm eyes with very contracted fields." In nearly all cases there was a definite improvement in vision. In some cases deterioration progressed.

(4) Delayed refilling of the anterior chamber was due to: (a) too free leakage of aqueous; (b) deficient secretion of aqueous; (c) escape of vitreous at operation if the incision was too far back. Occasionally there was intraocular hemorrhage. Sympathetic ophthalmia was rare. Operation was done with a small thin Graefe knife (not with a keratome); a very oblique and small incision, 4 mm. (inside) was made in order to produce as small a prolapse as possible. Herbert operated without previous use of eserine. He felt it necessary to have some conjunctival edema result (so as to pit on pressure with a probe).

[The Schiötz tonometer was presented to the profession in March, 1905.]

Although Lagrange made repeated assertions that it was unwise and unsurgical to allow iris to be incarcerated in a scleral wound, our story would not be complete without a few references to his attitude and to his contributions, for he wrote extensively at the very time that iris-inclusion operations were being proposed. At first he was very much in favor of sclerectomy, but by 1907[17] he advocated the combined operation of iridectomy and *sclerectomy* (not *sclerotomy*) for chronic simple glaucoma. He maintained that a simple scleral incision with or without iridectomy was no more satisfactory than iridectomy itself, because the lips of the wound healed and did not continue to filter. He here reviews the contributions of Bader, Walker, Herbert, and Holth, their advantages and disadvantages (especially the dangers of sympathetic disease and infection) and then describes his own operation, which in brief, is as follows:

(a) Eserine instillation preliminary to operation to free the iris angle as much as possible so as to allow for better

section. This also would reduce the possibility of iris entanglement in the wound.

(b) Local anesthesia, combined with instillation of adrenalin.

(c) Incision with a thin Graefe knife; the puncture and counterpuncture should be made much as in a cataract operation but less extensive, and should be oblique and quite far out in the iris angle to include a scleral lip and a large conjunctival flap.

(d) Sclerectomy; when the flap is pulled down, the scleral lip must be removed without buttonholing the conjunctiva.

(e) "Iridectomy in the usual way"—Lagrange unfortunately does not give details about tearing the iris from the root or replacing the pillars; the pictures would indicate he did not intentionally leave iris in the wound.

A few months later, in the Annals d'Oculistique, is given the paper which Holth[18] presented to the French Ophthalmological Society: "Iridencleisis antiglaucomatosa."[19] Holth gives deWecker credit for showing that the filtering properties of the corneoscleral cicatrix constituted the active element of the operative treatment, and for being the first to substitute the anterior sclerotomy for the iridectomy. Holth began to do Graefe's iridectomy in 1891, but became dissatisfied with the results. About 1893 he began to notice that in certain cases, in spite of irregularities of cicatrization, the results were better; such cicatrices presented at one or both ends of the line of incision a small bulla or a diffuse edema of the nearby conjunctival tissues. These formations have been given the name, "cystoid cicatrix," or "filtering cicatrix," after the theory of deWecker. Holth explains: "The cause of these I have always found to be in the entrapment of the iris even when it was not visible at the level of the cicatrix. I prefer the term 'fistular cicatrix,' as the entrapped part of the iris in the cicatricial tissue determines the fistulous tract. The cystoid cicatrix is not the same thing." Holth cites several examples of patients in whom one eye was correctly operated on and surgery on the other eye poorly done; the results of which were that the eye correctly operated on became blind, whereas the one poorly operated on retained the vision and a lowered tension.

On August 26, 1904, after having operated upon several animals, Holth finally had the courage to try out the idea of purposely encarcerating a fragment of iris in the angle of the wound when doing a subconjunctival iridectomy on a patient with absolute glaucoma. He mentioned his scruples: (1) Glaucoma can be produced in an otherwise well eye by anterior synechiae; and (2) infection. To meet the drawbacks: (1) He incarcerated the iris in the scleral part of the limbus, and (2) he made the conjunctival cover large and thick.

Holth's technique after several trials became the following:

(1) Local anesthetic combined with adrenalin.

(2) Lance knife (keratome). With the point he picked up the conjunctiva 5 to 8 mm. from the limbus, and entered the chamber 1 mm. behind the limbus. At times he did the operation with a Graefe knife, either (a) from above or (b) from the 2-o'clock or 10-o'clock position. In the latter case, (b), he would enter the conjunctiva 5 or 6 mm. from the limbus, enter the sclera 1½ mm. from the limbus, cross the chamber just anterior to the iris, reënter the angle and sclera, coming out in a symmetrical position on the other side, both through sclera and conjunctiva; he did not finish the scleral section as is done in the Lagrange operation. He could then do two iris-inclusion operations with the one scleral thrust.

(3) He preferred the corneoscleral wound to be short—not over 5 to 6 mm. long—and he usually used a stop keratome.

(4) In removing the keratome he was very careful to depress the heel and raise the point so as not to injure the lens.

(5) He grasped the iris either at the pupillary margin (if he wished to cut the sphincter) or more toward the periphery, withdrew the iris and cut it radially, using the deWecker scissors, but was very careful not to cut off the prolapse. Thus a portion of the iris was left attached (hinged) and this was drawn into a corner of the scleral wound.

(6) He did not use an iris spatula, as that injures the iris pigment epithelium.

(7) He did this operation on many eyes in which an iridectomy had previously been done.

(8) Occasionally a thin glassy bulla would form over the operative wound; this would be sharply outlined at the sides, indicating that the aqueous was not draining away freely into the nearby tissues. In such cases he would undermine the bulla from nearby and advocate massage. He attempted to produce a small edematous cushion over the corneoscleral wound.*

In some cases the iris slipped back into the chamber; in others, no conjunctival edema was demonstrable even though the tension remained low; in still others miotics were of benefit postoperatively even though they had been almost useless preoperatively. Holth emphasized the necessity of avoiding operation so long as there was infection in the lacrimal passages. Occasionally pupillary synechiae formed, but no K. P. or other serious complications. He said Lagrange's success with sclerectomy with or without iridectomy was probably at least in part due to postoperative rupture of the very large scleral wound, either momentarily with immediate reëstablishment, or with hernia of a bit of the edge of the iris.

From 1909 to 1911, Johann Borthen[20 23] of Norway wrote about a variation in the iris-inclusion operation, which consisted essentially (1) in instilling atropine about 15 minutes before the operation, and (2) in omitting the cutting of the iris. One further difference in the technique was that Borthen *always* grasped the iris in the pupillary margin and pulled it out far enough so that the pigment layer of the prolapse would face anteriorly. He emphasized, first, that the iris should not be pulled *too far* out of the chamber, and, second, that the limbal incision should not be too large. If the iris is pulled too far out of the incision, the pupil will be dislocated too much, and if the incision is too large, the iris will retract into the wound. He named this operation "iridotasis," because he said it was the pulling and stretching of the iris that produced the beneficial results.

"I believe that my operation, far from being a minor variation of Holth's procedure, casual and unessential in character, is, on the contrary, one which produces essential and radical changes in the mechanism of healing. Incision of the iris, iridotomy, may nullify the very effect, that of permanent drainage, which it was to promote. The very fact, on the other hand, that the iris remains uninjured, according to my suggestion, and is merely drawn out and stretched, may account for the excellent results as to filtration and fistulization with the attendant permanent reduction in tension . . . the radial arrangement of the fibers . . . the crypts appear longer, the contraction furrows smoothed out . . . the pupil drawn away from the center. . . . I believe this traction itself indirectly affects the ten-

* He demonstrated in one case through a folding of the iris a small pigment-lined fistulous tract through the sclera, leading into the subconjunctival space.

sion, much in the same way as, but more actively than, eserine and active accommodation; there is increase of drainage through Fontana's spaces in direct consequence of the stretching of the iris. . . . The more rapid and effectual reduction of tension after iridotasis, as compared with the results of iridencleisis, would speak strongly in favor of this theory. The latter operation makes all stretching of the iris impossible and any reduction in tension is due to transcleral filtration solely. . . . Finally, it is worth noting that iridotasis may be ineffectual where the iris is atrophic, even if subconjunctival edema appears over the prolapse—probably due to permanent obliteration of the iris angle and atrophic changes in the stroma iridis. . . . In conclusion, I wish to lay stress on the importance of operating under atropine mydriasis, so that complete paralysis of the iris may prevent spontaneous reposition; the advisability of avoiding forcible traction on the iris after it has been brought through the scleral section, so as not to draw up the pupil; and the necessity of a somewhat more liberal scleral section, 8 mm. in very old patients with rigid iris."

To these statements, Holth[24] replied: Borthen seemed to think that the fistulous scar was not the explanation of the good results of the Holth operation; and that the drawing of the iris away from the opposite angle, the clearing of Fontana's space and the stretching of the iris tissue, were the important elements in the iridotasis. This, in spite of the fact that Holth had shown microscopic sections of seven eyes, demonstrating fistulization. In doing the Holth operation, Borthen used only one form (tongue form of the Holth operation, the least satisfying form) and he had done this only 16 times. Borthen excluded from his series, cases of inflammatory glaucoma, such cases as were included in Holth's original contribution. Borthen also called cured, cases with a tension of 30 mm., whereas Holth put these in the only partially successful group, that group requiring postoperative miotics. Furthermore, Borthen did not make mention of the fact that the tension of an eye is reduced after several trials with the tonometer; Holth reported the tension after the first trial and Borthen possibly after several trials. Borthen disregards as unimportant in normalizing the tension the very evident cushion of the conjunctiva opposite the scleral incision. This cushion may be nonexistent if the communication channels lead directly to Tenon's capsule. He does agree that Borthen's suggestion of atropine immediately before the operation is a good one. Holth's operation never dislocates the pupil, and can be used in cases of atrophic iris, in which cases the Borthen operation is of little value.

David Harrower, of Worcester, Masschusetts,[25] was apparently the first in the United States to try, or at least to write about his experience with the iridotasis operation. His paper was read at the American Ophthalmological Society meeting in Washington, D.C., in May, 1913. He quotes Borthen as saying it was an improvement over the operation of Holth (1907), called iridencleisis, or iris incarceration.

Harrower agreed with Borthen as to the inadvisability of incising the iris, believing this portion of the operation to be unnecessary. He was convinced that the same effect could be produced by inclusion of a fold of iris, allowing the posterior surface to coalesce with the subconjunctival tissues thus assuring a position of the sphincter external to the section, and, with this, free drainage. This modification had the advantage of avoiding a step of the operation, incision of the iris, which requires skillful technique and a good assistant to hold the conjunctival flap down on the cornea during iridotomy. This idea was suggested to Borthen by the

observation of a case of rupture of the corneoscleral margin by blunt violence with incarceration of the iris under the uninjured conjunctiva. Tension was subnormal and the eye free from irritation; this condition remained unchanged as long as the patient was under observation. Borthen's operation is intended to produce the very condition observed in this case.

The operation (still quoting Harrower) is performed as follows: The conjunctiva is grasped with fine straight forceps about 10 mm. behind the upper limbus, and a cut 2 to 3 mm. long is made in the raised conjunctival fold with ordinary iris scissors. The scissors are then carried toward the limbus, dissecting a conjunctival flap and keeping as near to the scleral surface as possible in order to include a large amount of subconjunctival tissue in the flap. Care must be taken to avoid fenestrating the conjunctiva near the limbus, as this would not only expose the incarcerated iris to infection, but interfere with filtration as well. The globe is now held with fixation forceps, and the lance knife with stop introduced about 1 mm. behind the corneoscleral margin, and carried down through the anterior chamber until the section is 4 to 5 mm. long. The conjunctival flap can be made by means of the lance knife when making the incision, but the dissection with the scissors insures the inclusion of subconjunctival tissue in the flap, and he believes this is a matter of practical importance for filtration and the formation of a subconjunctival bleb. The iris is now grasped at the sphincter with the iris forceps, taking up a fold 1 mm. wide; it is drawn out through the section and left there. . . . A drop of atropine, instilled 10 minutes before operation, will insure the permanency of the prolapse, and does not cause increased tension.

Harrower reported two cases. In the discussion, 6 or 7 of the prominent members either condemned the procedure as most dangerous, or were very skeptical, Edward Jackson only being kindly disposed. Critchett's operation "iridodesis" was mentioned by Samuel Theobald of Baltimore.

A few years later,[26] in 1917, Harrower gave another paper entitled "Five years' experience with iridotasis," before the same Society. By that time, he had performed the operation on 23 eyes. He had varied the technique only slightly by using dissecting scissors and hugging the sclera. In the discussion which followed, it developed that he had not tried the recent modification made by Borthen of buttonholing the prolapsed iris.

Numerous other papers have appeared in the American literature, notably, two by Dunbar Roy,[27, 28] one each by W. H. Wilder,[29] Clapp,[30] Muncy,[31] Constantine,[32] Works,[33] Ziporkes,[34] and Greenwood.[35] Also in the 1933 British Transactions of the Ophthalmological Society of the United Kingdom appears an extensive article by Holth[36] and one by Wright.[37] There are other contributions also, but none of them has developed material alterations in the technique, and their results for the most part confirm the claims in the earlier papers.

Dunbar Roy reported five cases in 1916. In four of these cases both eyes were operated upon. He mentioned the fact that he had been told Borthen had discontinued the operation, so he wrote him and this is part of Borthen's reply: "Since 1908 I have in all performed iridotasis in 242 cases, with so highly satisfactory results that I have not felt inclined to try any other. I am convinced that the reduction of tension is due, not to filtration, but to increased drainage through Fontana's spaces in direct consequence of stretching of the iris. It is quite unnecessary to make the conjunctival flap larger than just sufficient to cover the incarcerated iris."

Wilder's contribution gives a condensed report of 36 consecutive cases. From my many years' association with him I know how insistent he was on the production of as thick a flap of conjunctiva and episclera as possible, whether he did the iridotasis of Borthen or the iridencleisis of Holth.

Allen Greenwood combined a sclerectomy with iridencleisis or with iridotasis if the tension was unusually high or apt to go high. He made a very oblique scleral incision, beginning farther back than was formerly advocated and entered the anterior chamber as far in the angle as possible. He thus had a shelf of sclera quite like that produced by the Lagrange incision, which shelf could be cut off or punched with Holth's punch forceps. He then followed by incarcerating the iris in one or both corners of the scleral wound. "No postoperative massage is necessary."

In 1922 Schlosser[38] wrote of a minor change in technique which he said he had been using since 1904. He made a narrow Lagrange sclerectomy as much under conjunctival cover as possible with almost no cutting of the conjunctiva itself. He would prolapse the iris by pressure on the globe. If this was unsuccessful he would grasp it in the middle zone with forceps and pull it well into the wound, and then use scopolamin. A binocular bandage was used for 24 hours. It might be necessary to transfix the prolapsed iris 10 to 14 days later.

The development of the iris-inclusion operations was retarded from time to time by statements of men high in the ranks of ophthalmology, men whose very name commanded confidence. For instance, Paul Roemer,[39] professor of ophthalmology at Greifswald, made these statements since Holth's contribution in 1907:

"The formation of a conjunctival flap is to be avoided because, in the first place, the vessels there are apt to bleed considerably, and, in the second, a conjunctival flap favors the formation of a cystoid cicatrix. . . . If a tag of iris is caught in the angle of the wound we try to seize it with forceps and abscise it, or we may introduce a small spatula and push it back into the normal position. Such incarcerations of the iris are dangerous, because they delay the healing of the wound, or render the regulation of the tension difficult" (p. 498). [I have no doubt that he had tried the Herbert operation in somewhat the manner I have seen that operation done—that is, with a small conjunctival flap which is dissected down to the limbus on each side, thus inviting a tight cicatrix around the prolapse. I have noted in many descriptions of the operative technique of opening the anterior chamber with a keratome that the point of entrance was 1 to 1½ mm. behind the clear corneal border in the 12-o'clock meridian. This position in my experience is apt to be too far forward, depending somewhat on the prominence of the limbal vessels. Many operators do not thrust the keratome through the limbus perpendicularly to the cornea for fear of injuring the iris and even the zonule of the lens; when they do, it usually enters the chamber 0.5 mm. or more in front of the pectinate ligament. Such eyes examined later with the gonioscope are found to have iris tissue at each side of the coloboma adherent to the pectinate ligament, often also to the cornea itself, thus effectually blocking the entrance to the Schlemm canal (T.D.A.).]

Elliott[40] condemns all iris-inclusion operations with this remark: "It seems strange that a procedure which is so obviously unsound can find any advocacy at the present time. Much as the author desires to avoid any suspicion of intolerance and bigotry, he feels that there are certain operative methods which are seri-

ously entertained today, which stand self-condemned at the bar of modern pathology and surgery. The effort to produce the entanglement of iris in a scar is, in my opinion, one of such."

Berens[41] criticizes severely all inclusion operations with these words:

"(1) It is unsound in principle, for in all other intraocular operations or in penetrating injuries, it is found that eyes in which there is iris entanglement or a prolapse, remain irritable longer than those in which these complications are absent, and every care is taken to avoid them.

"(2) Iris prolapse is one of the chief factors in the causation of sympathetic ophthalmitis.

"(3) Late infection after trephining is frequently if not always, associated with entanglement of uveal tissue in the wound."

On the other hand deSchweinitz[42] is somewhat noncommittal.

"One of the complications which may follow the operation of iridectomy in glaucoma is the formation of a bulging scar at the seat of the incision, sometimes called a cystoid cicatrix. This is especially true if due care has not been taken to free the angles of the wound from adherent iris. On the other hand, in severe cases, this very cystoid cicatrix, by permitting a filtering of the liquids, has been regarded as a favorable condition. In this condition the modern operations for the relief of glaucoma, by means of which a filtering area is produced, must be considered. They are discussed on p. 629." After considering several sclerectomy operations in some detail he gives about 12 lines to the iris-inclusion operations.

Fuchs's textbook[43] (Duane translation) contains this sentence (with reference to iridectomy): "Incarceration of the iris in the wound after operation should be avoided by careful reposition." And on page 983 Duane adds an 11-line paragraph on iridotasis, without any comment. He mentions Holth's punch forceps operation but not his iridencleisis.

Gjessing,[44] in 1939, advocated the iridencleisis operation but, preliminary to doing it, he takes about 400 c.c. of blood by phlebotomy. And finally Ballantyne[45] sums up the situation in his paper, "The choice of operation in glaucoma" by comparing the operative procedures advocated from the time of George Critchett and Coccius on, with the conclusion that the choice of operation depends on many factors. He does not favor iridotasis, as he thinks the sphincter should be preserved, both because of the frequent necessity to continue miotics and because it gives a better cosmetic result.

Summary

In this article an attempt is made to show the methods used by the early ophthalmologists to relieve suffering and postpone blindness; first, in the prescientific era from approximately 1800 to 1850; second, in the early scientific era from 1850 to 1900; and finally in the last 40 years.

During the first period, diagnosis was very crude, medical treatment was very severe, and surgical treatment was done in an empiric manner.

In the second period, as a result of more exact methods of examining the living eye, as well as the enucleated eye, there was an improvement in the technique. This was aided by an international interchange of opinions by the leaders in various countries. As a result of this certain opinions, which had been considered true, had to be questioned. Clinical observations improved in quality, and, from the second stage, gradually is evolving the third stage of more exact diagnosis and more logical treatment.

Several operations such as the trephine

and cyclodialysis have hardly been mentioned because in advocating them the authors have never suggested that iris be included in a scleral section; in fact meticulous avoidance was impressed upon all who would attempt them.

122 South Michigan Avenue

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CLINICAL APPLICATION OF THE SCREEN (COVER) TEST DESCRIBED IN DETAIL

JAMES WATSON WHITE, M.D.
New York 16

Any test used for the determination of imbalance of the ocular muscles must be: (a) accurate, (b) precise, (c) quickly applicable in a large percentage of cases. It should make possible: (d) the measurements of tropias as well as of phorias; (e) the measurement of the amount of deviation when suppression is present and binocular vision is impossible. (f) It should be accurate in children too young to appreciate double images as required by many of the tests. (g) The more objective and the less subjective a test the better.

Many of the tests in vogue are purely subjective and measure only the phorias and the lesser amounts of tropias when suppression is not present.

Most tests are used to measure the deviation for distance only, while some are used to measure it for distance and near, but only in the primary position. If a measurement is desired in the six cardinal fields, an entirely different test is necessary, which may alter the fusion tendency entirely. This is not so with the screen test.

Duane, in an article on the parallax test, written in 1895, stated: "As far as my experience goes, the impulse towards bringing two dissimilar images into line is almost as strong as when the images are alike." This has been the writer's experience in many cases, so many, in fact, that one is not safe in relying on any test which depends entirely on dissimilar images. The difference between these tests and the screen test is that the screen test measures more nearly the total amount of deviation, whereas the other tests measure only the amount that cannot be overcome, or the amount that the deviation is increased or decreased by the convergence action in binocular vision. This may vary by many degrees in different individuals or in the same individual at different times.

Before considering the application of the test, it would be better to consider the normal physiologic function of the ocular muscles.

One has to consider, first, the action of each individual muscle *per se*. Second, the action in associated movements as controlled by the cortical or subcortical area. Third, the act of convergence as controlled by the convergence center. Fourth, the function of divergence as controlled by the divergence center. Fifth, the function of sursumvergence with strong evidence of a center controlling the vertical adjustments, and, sixth, the function of rotation as shown by the position of the vertical meridians of the corneas.

The outer wall of the orbit forms an angle of 45 degrees with the nasal wall, and with the visual axis of the eye in the primary position, an angle of 26 degrees.

Consider each eye as moving on three axes—a vertical axis for inward and outward rotations; a horizontal axis on which the eye elevates or depresses; and an antero-posterior axis on which the eye is intorted or extorted. Listing's laws (see page 29 in "Duane's Thesis") may all be proved by this concept but are unnecessary to clinical ophthalmologists. The external rectus and the internal rectus are the only muscles that have at all times a straight line of traction and hence an uncomplicated action of abduction and adduction and act only on the vertical

axis. Since the superior and inferior recti have their origins at the orbital foramen, the direction of each muscle is forward and outward. This causes the muscles, when the eye is in the primary position, to make traction at an off axis of approximately 26 degrees. Considering the eye as rotating on a vertical, horizontal, and antero-posterior axis, such an angular action would cause the superior rectus to elevate the eye on the horizontal axis, to adduct the eye when acting on the vertical axis, and to intort the eye by the action on the antero-posterior axis. The inferior rectus in the primary position depresses the eye on the horizontal axis, adducts on the vertical axis, and extorts on the antero-posterior axis. Since there are these three actions of each muscle in the primary position, the actions would be simplified if the traction could be made straight. This can be done by rotating the eye to the outer canthus, mainly by the action of the external rectus. In this position, the superior rectus, having a straight line of traction, is practically a pure elevator. The inferior rectus, working parallel to it, would then, in this position, be a pure depressor.

Since the effects of duction and torsion are caused by the off-axis tractions, these effects would be increased as the angle of the traction is increased. This would be in the nasal field.

A like condition is present in the case of the oblique muscles, except that the off-axis pull is about 43 degrees. In the primary position the inferior oblique elevates the eye on the horizontal axis, abducts on the vertical axis, and extorts on the antero-posterior axis. The superior oblique in the primary position depresses the cornea on the horizontal axis, abducts on the vertical axis, and intorts on the antero-posterior axis. When the cornea is well in the nasal field, these two muscles have almost a straight line of traction. Hence, in this field, the inferior oblique is almost a pure elevator, while the superior oblique is almost a pure depressor.

Since, in the primary position, the elevators and depressors each have three functions, making 12 functions to watch in each eye, or 24 in all, and, added to this, the function of associated movements, convergence, divergence, and sursumvergence, it is small wonder that the question becomes complicated. It seems reasonable to assume, however, that if an elevator or depressor in underacting or overacting, as such, it is doing the same thing in its other functions; hence, if, for instance, a superior rectus fails in elevating the cornea in the temporal field, one can assume that the underaction is also present in the function of adduction and intorsion in the nasal field, and all functions are least affected in the primary position. All one needs to do, then, is to test the elevators and depressors in the field in which the act of elevation and depression is greatest, and the diagnosis is made from the comparative amount of elevation or depression of the eyes alone, disregarding their secondary actions of torsion and duction.

Exophoria and Exotropia

With these physiologic actions of the extraocular muscles in mind, what could be the cause of an exophoria? It could be brought about by the weakness of one or both interni, or by an overaction of one or both externi. It could also be produced by an underaction of the convergence power with normal interni in their functions of adduction. It could also be caused by an excess of the divergence function. In itself, then, the finding of an exophoria means nothing until the test is repeated for the near point. It still means little unless the test is made when the eyes are turned to the right and to the left. If

the exophoria or exotropia is greater for distance than for near and does not increase in looking to the right or to the left, a diagnosis of a primary divergence excess can be made. If the exophoria or exotropia is greater for near than for distance, a convergence insufficiency or paralysis is the primary lesion, again provided that the deviation does not increase when the eyes are turned to the right or left. If the divergence of the visual axes increases in looking to the right, there is a paralysis, more or less marked, of the left internus or, more rarely, a spasm of the right externus. If the deviation increases in looking to the left, the conditions are reversed; that is, a paralysis of the right internus or a spasm of the left externus. If the exophoria or exotropia increases in looking to both the right and to the left, there is a paralysis of both interni. The exophoria or exotropia of a divergence excess or of a convergence insufficiency is never more, and usually it is less, in looking to the right or left than it is in the primary position.

Esophoria and Esotropia

An esophoria may be due to a weak power of divergence that is divergence insufficiency or to paralysis; to a too-powerful converging power (convergence excess or spasm), or, again it may be due to a weak external rectus or to a too-powerful internal rectus.

This may be determined by measuring the amount of deviation for distance, near, and when looking to the right and to the left.

Hyperphoria and Hypertropia

If a right hyperphoria is found by any test in the primary position, what does it mean? The test shows only that the right eye is higher than the left eye. This may be produced by an excessive power of sursumvergence, to an underaction from any cause of the depressors of the right eye, or to an overaction of the elevators of the same eye. It could also be brought about by an underaction of the elevators, or by an overaction of the depressors of the left eye. In a left hyperphoria, the reverse is true. To determine which muscles are involved, the deviation must be measured in the upper and lower corners. This, to be sure, tests the associated muscles in their respective fields as elevators or depressors only, but if found defective, or excessive, as such, they are over- or underacting in their secondary functions of duction and torsion, as has been previously stated; although these functions seem in many cases to be compensated for by the action of the other muscles. Primary paralyses are very common, whereas primary spasms are seen quite infrequently. However, secondary contractures of direct antagonists and secondary deviations of the associate muscles are very common.

It is necessary, then, in order to make a definite diagnosis, to know not only the amount of deviation for distance and for near, but also in the six cardinal positions as well. The screen test is most satisfactory, as all measurements can be made by it. This should be followed by the screen-comitance test, to be described later.

Requisites for making screen test

Source of light. Light must be diffuse, so that the examiner may clearly see the cornea, pupils, and the movements of the eye; free from glare and brilliance, so that patient and examiner are not blinded nor disturbed in any way by the light. This test is purely an objective test and depends entirely on the observations of the examiner.

Size and position of test object. The test object must be large enough to be seen at the desired distance. The usual

position is at 20 feet for distance, 33 cm. for near, for the eyes front position. A diagnosis is often aided by making tests at 15 feet, 10 feet, 3 feet, 0.5 m., and 0.25 m. It also is important in some cases to make tests at 50, 100, and 200 feet. These variations are especially important in convergence excess and spasm and in divergence insufficiency and divergence excess.

When examining in the six cardinal positions, one should hold the test object at 50-75 cm., but in the same relative position, since the relation of one position to another is more important than the actual amount of the deviation. In paralytic cases, the test object must always be held just within the point of possible fixation. In paralytic cases, especially, one must watch corneal reflexes and movement to fixate, since the patient may prefer eccentric fixation. This is especially so if a bright light is used as the object to fixate, in which case it is better to use a dim light, or some object that the patient must fixate centrally. The size and brilliancy of the object must be reduced in order better to study the effects of the accommodation; for example, small type or other objects that would require more accommodative effort for either distance or near or for both.

Screen or cover. The most satisfactory screen is 6 by 15 or 18 cm. It must be so large that the examiner does not need to watch its position carefully. This enables him to pay more attention to the movements of the eyes. The small round screens or complicated screens are not recommended.

Position. The screen should be held so that it comes directly in line of the object to be fixated but held far enough in front so that the covered eye can be seen by the examiner. It should be held so that when moved to the other eye, it does not touch the end of the nose. One-half to one inch is usually enough. To place the screen close to the eye prevents the examiner from observing the covered eye, slows down the test, and is unpleasant to the patient.

The screen should be moved almost entirely by wrist motion, as in casting a fishing lure. It should be moved no faster than the examiner can see the patient change fixation. This depends on macular vision and the ability to fixate, also on the coöperation and concentration of the patient.

Prisms to be used. The most satisfactory prisms are the square unmounted prisms, about 4 by 4 cm. in size, increasing from 1^{Δ} to 10^{Δ} by 1^{Δ}, from 10^{Δ} to 20^{Δ} by 2^{Δ}, and, in addition, 30^{Δ} and 40^{Δ}. A 50^{Δ} prism is on the market but is not recommended, since it must be held most accurately in order to avoid total deflection. With more than 40^{Δ} of deviation, it is better to divide the prisms, as for example, to correct 60^{Δ} place a 30^{Δ} before each eye or to correct 70^{Δ} place a 30^{Δ} before one eye and 40^{Δ} before the other. When large amounts of deviation are present an assistant or the patient himself may hold part of the total prism correction before one eye while the examiner holds the remainder before the other. A prism bar or a rotary prism is not advised for this test. Prism should be held in the symmetrical position (an equal amount of slant on each side of the prism), or the postero-normal position, where the flat face of the prism is next the eye and the slanting face in front.

An objection made to the prisms on the market is that they are not scientifically perfect. This has been found to be true, but since a diagnosis depends on the relative amounts of deviation for distance, near, and in the six cardinal directions,

rather than on the precise number of degrees, the factor of inaccuracy does not influence the diagnosis.

Technique of Learning the Screen Test

Select a person with little or no deviation. Hold a prism base out before either eye and screen until a reversal is produced. Then hold the same prism base in, base up, and base down, until a reversal is produced. Reduce the strength of the prism until 1^{Δ} or 2^{Δ} is seen to cause a reversal.

If this practice is used, one is soon able to see and even estimate quite accurately the amount of deviation and is soon able to judge an approximately correct prism on the first few movements of the screen. The screen test is tedious and tiring and time consuming unless this technique is acquired.

The examiner, if presbyopic, should use a strength of glass of about that used for piano or cards. A high bifocal is preferred, so that the examiner need not throw his head back to use his near addition.

Combined lateral and vertical deviation. If there is a combined lateral and vertical deviation, the prism should be placed base in or base out to correct the lateral deviation, together with a prism, base up or base down, to correct the vertical deviation. This cannot be accomplished as satisfactorily by any other test used in any way. When examining in the six cardinal fields, the examiner should hold the prism as accurately as for the primary position, but always so that the eye or eyes before which the prisms are placed are surely fixating the test object.

Changing prism behind the screen. Not infrequently more deviation develops by more completely breaking up fusion. This is done by keeping one or the other eye constantly screened. The increasing amount of deviation is measured by increasing the strength of the prism before either eye, before moving the screen to the opposite eye. This may be done in any position of gaze.

Kinds of deviation. Deviations may be due to the underacting or the overacting of muscles for any reason. They may be due to anomalies of associated movements from cortical or subcortical areas. They may be due to anomalies of convergence, divergence, sursumvergence, or rotations. The examiner must determine which one of these functions is at fault, or whether the deviation is due to an overaction or underaction of one muscle or function, or to a combination of two or more muscles and/or functions.

Orthophoria. In true orthophoria, a screen placed before one eye will not cause it to deviate from the object fixated by the fellow eye. When the screen is moved to the fellow eye, there will be no movement of redress.

Esophoria and Esotropia. When the right eye is covered, it may be seen to converge behind the screen, while the left eye fixates. When the screen is moved to the left eye, the right eye rotates outward to fixate (movement of redress); this is an homonymous screen. With the right visual axis turning to the left or the left visual axis turning to the right, behind the screen, the eyes are in a position to have homonymous diplopia. The patient may observe the test object moving in the opposite direction to the movement of the screen; this is an homonymous parallax. If either eye when uncovered remains in a convergent position, an esotropia is present. This may be a truly alternating esotropia, or either eye may

be chosen to fixate, showing a right esotropia or a left esotropia. However, if the fixating eye remains fixed when on removal of the screen the other eye moves out to fixate with its fellow, an esophoria is present. These observations should be made not only in the eyes-front position, for distance and near, but also in the six cardinal fields, as fixation may change as the gaze is directed to different positions. Esophorias and esotropias are measured by placing the prisms, base out, until the redress is entirely stopped. If just over corrected, 1^{Δ} or 2^{Δ} should be deducted.

Exophoria and Exotropia. If, on covering the right eye, it is seen to diverge behind the screen and the redress is a movement in, to fixate, an exophoria or exotropia is present. If, on removing the screen, both eyes are seen to fixate, the deviation is an exophoria, but if one eye diverges while its fellow fixates, there exists either a right exotropia, left exotropia, or alternating exotropia. If diplopia were present, it should be a crossed diplopia, since the visual axes diverge. On moving the screen from one eye to the other, the eye follows the screen (crossed screen). The test object should be seen by the patient to move in the same direction as the eye or screen (crossed parallax). These should coincide and be measured with prisms, base in.

Hyperphoria and Hypertropia. The terms hyperphoria or hypertropia, and hypophoria or hypotropia, are confusing terms and cannot be used properly until a diagnosis is made. When the diagnosis is made, these terms are inadequate to describe the condition. A right hyperphoria means only that the right eye is the higher of the two. This may be produced by an underaction of either depressor of the right eye or to an overaction of either elevator. The right eye may again be higher because the left eye is not high enough. This could be caused by an underaction of either elevator of the left eye or to an overaction of either depressor.

When a right hyperphoria is found to be caused by a paralysis of the left superior rectus, it is a left hypophoria, which tells but little, but when called a paralysis of the left superior rectus, one knows at once that the deviation increases in eyes up and left. The writer uses the term Hyper, designating whether it is a right hyperphoria or hypertropia, or a left hyperphoria or hypertropia.

If when screening the right eye, the eye is seen to be up behind the screen, or is seen to come down when the screen is moved to the other eye, a right hyperphoria or right hypertropia is present. If, on removing the screen, the left eye remains fixed, and the right eye lowers to fixate with it, a right hyperphoria is present. If the right eye remains high, or if, when it comes down to fixate, the left eye goes still lower, a right hypertropia is present. If double vision is present, it is a DR (right diplopia) with the image of the right eye lower. The patient should observe the image dropping (right parallax). The reverse is true in a left hyperphoria or left hypertropia.

Double hyperphoria or double hypertropia is frequently observed. When the screen before the right eye is moved to the left eye, the right eye is seen to come down to fixate. However, when the screen is moved back to the right eye, the left eye comes down to fixate. This proves a double hyperphoria or hypertropia. This is measured by placing prisms, base down, before the right eye until the downward movement of this eye is stopped. Little attention is paid to the left eye, while the right hyperphoria is being measured. Then prisms are placed, base down, before the left eye until all downward

movement of this eye is stopped. Double hyperphoria and hypertropia in the writer's belief proves a paralysis, more or less marked, of the corresponding elevator or depressor of each eye. Double hyperphoria may remain such if, for example, there is an equal paralysis of each inferior rectus, even though this is marked, but when the right inferior rectus (for example) is more paretic than the left inferior rectus, a right hyperphoria or hypertropia is dominant. An esotropia or an exotropia is frequently present. These should be corrected by prisms, base out or base in. The choice of the fixating eye may change the picture considerably when the deviation in the six cardinal fields is measured.

Primary deviation. When the nonparetic eye fixates normally, the paretic eye lags behind. The paretic eye is said to have a primary deviation.

Secondary deviation. When the paretic eye is required to fixate, the fixation is slower than normal, with a nystagmoid or jerky movement. This requires a special attempt to innervate the paretic muscle. The nonparetic eye, receiving the same amount of increased innervation, is markedly overacting (secondary deviation).

When more prism is required before one eye or the other in measuring deviations, the eye requiring the more prism is usually the nonparetic eye, and measures the secondary deviation. The paretic eye requires less prism. This observation is quite accurate in studying primary and secondary deviations.

Secondary contractures. A secondary contracture is developed when the nonparetic eye is more constantly the fixating eye. The direct antagonist to the paretic muscle is not restricted in its movements, and overacts more and more. For example: If the right inferior rectus is paretic, and the left eye is more constantly used to fixate, the right hyperphoria which at first is only in eyes down and right, increases in eyes up and right, due to a secondary contracture of the right superior rectus.

Position of test object in paretic cases. When using the screen test in the six cardinal fields, it is very important to keep the test object within the limit of possible fixation.

How much deviation can be measured by screen test? With coöperation and normal fixation, amounts of strabismus to 80$^{\Delta}$ or 100$^{\Delta}$ may be accurately measured. Care should always be taken to avoid total deflection.

Age of Patient. The amount of deviation can be estimated in a child of one year, and accurately measured before three years of age, if the examiner uses the proper child psychology and patience, with the test objects something that will hold the child's attention. The screen comitance test to be described later may be used in the six cardinal fields, with much success, at a very early age, by using a nursing bottle, toy, or some attractive object, which should be changed when the attention lags.

Parallax test

The parallax test is a subjective test and so is dependent on the coöperation and observations of the patient. Some patients have no trouble in observing the movement of the test object, whereas others are quite stupid about it; and this is often in inverse proportion to the amount of intelligence or education of the patient. It is a very delicate test when properly observed, and again is quite tedious and valueless when complete co-

operation is lacking. The writer uses it much less than formerly. The test is conducted at the same time as the screen test. As the examiner observes the eye moving, the patient is asked if he sees the test object move. When the eye reverses movement by the screen test, the patient should see the object reverse movement. For example, if the right eye diverges behind the screen, the eye is in a position to have a crossed diplopia and as the screen is moved to the left eye, the patient's right eye moves to the left and picks up the object which has seemed to him to have moved to the left. This is termed a crossed parallax. An homonymous parallax is observed in an esophoria or esotropia; a right parallax in a right hyperphoria or tropia; and a left parallax when the left eye is higher. The test is extremely sensitive in many patients with a slight hyperphoria and is often observed in amounts of less than 0.5Δ.

When the examiner sees the eye move in one direction, while the object seems to the patient to move in the opposite direction, it is termed a perverse parallax. This is observed chiefly in postoperative convergent strabismus, and is due to faulty projection. The test object should be flush with the background to prevent a normal parallax.

The youngest child to give an unsolicited answer to the test was 2½ years old. He said immediately that the light dropped down in a right hyperphoria. The test depends more on the power of observation than on the age or intelligence of the patient. When the screen and the parallax fail to correspond, an abnormal retinal correspondence is present. In observing patients, degrees of 0.5 or 0.25 degrees of arc or even less are observed.

Screen-Maddox rod test

This test was described by Maddox in 1898, and by others since. It is a most delicate and valuable test in slight phorias and tropias, especially hyperphorias.

The Maddox rod is placed before the right eye and the patient asked to fixate on a spotlight or candle. A screen is then placed before the rod to break up fusion still further. When the screen is removed, a right hyperphoria, which has been present, may have increased. A prism is then placed behind the screen and before the rod, of sufficient strength to cause the image of the rod to pass through the light when the screen is first removed.

When the rod is placed before the left eye, a right hyperphoria may still be found but may be somewhat greater or less than before. Usually the eye showing the greater hyperphoria or hypertropia of the same kind indicates a secondary deviation or secondary contracture of this eye. The screen-Maddox rod test may also be used to measure esophorias or exophorias but is not so reliable as the screen test alone.

However, and not infrequently, when the rod is placed before the left eye, a left hyperphoria is observed, whereas a right hyperphoria was found with the rod before the right eye. One is now dealing with a double hyperphoria and careful measurements in the upper and lower corners will reveal a paresis of a pair of elevators or depressors, the same muscle in each eye being paretic. For example, while in the primary position, there was a 1 prism degree of right hyperphoria when the rod was over the right eye, there was a left hyperphoria of 1 prism degree with the rod before the left eye. A left hyperphoria of 3 prism degrees was found in eyes up and right, while in eyes up and left there was a right hyperphoria of 3 prism degrees; other fields being normal, there is proved a slight paresis of both superior recti, and the use of the screen-Maddox rod before each eye in turn was the means of finding it. Again,

when the right hyperphoria so measured in the primary position is 2 prism degrees and the left hyperphoria is 3 prism degrees, it will be found that the left hyperphoria in eyes up and right is greater than the right hyperphoria in eyes up and left, proving the right superior rectus to be the more paretic. Definite relief of symptoms may be obtained by prescribing the difference in amount—in this case, 1 prism degree. This is better placed before the eye showing the larger amount of hyperphoria.

Screen-comitance test

In the screen-comitance test, the screen is held in such a way that while the patient sees the object with only one eye at a time, the examiner is observing the movements of both eyes. This test should be made in the six cardinal positions and may be made at the same time as the screen test, but is better made as a separate observation.

When making the test with the sound eye fixating, the paretic eye is seen to lag (primary deviation). When fixating with the paretic eye an extra stimulus is necessary to fixate an object in its normal field of action; the associate or yoke muscle of the other eye receives the same added impulse and overshoots. This is termed secondary deviation and is always greater than the primary deviation. Usually the greater the paresis, the greater the secondary deviation. In extreme cases this is not so, since the muscle may be so paralyzed that fixation is not attempted and hence the secondary deviation is correspondingly small, or lacking entirely.

Movement of redress

The examiner screens the right eye, which is seen to be in a position of convergence behind the screen. When the screen is moved to the left eye, the right eye comes out to fixate (movement of redress), while the left eye is turned in behind the screen.

The movement of redress is the attempt of the patient to change fixation when the screen is passed from one eye to the other and a prism of the correct amount will stop all movements. Occasionally the uncovered eye—for example, in an esotropia—will swing out sharply and too far, and in order to fixate the test object, the eye must come in. Since the first movement was outward, the esotropia is still undercorrected and more prism must be placed, base out, until the first movement is that of a crossed screen. This is observed also in exotropias and hypertropias.

Homonymous screen

When the covered right eye is turned in behind the screen, it must come out to fixate when the screen is moved to the left eye. This is an homonymous screen and is measured by placing prism, base out, before one eye or the other, or in deviations of over 40 prism degrees, by using prism, base out, before both eyes until the deviation is just overcorrected. The visual axes are in the position to have an homonymous diplopia. The patient would see the object move in the opposite direction to the screen, homonymous parallax.

Crossed screen and Parallax

When the eye that is screened turns out, there is an exophoria or exotropia. The examiner determines which and measures the amount by a prism placed base in. This patient should have a crossed diplopia and moves the eye in to pick up the object on the opposite side (crossed parallax).

Vertical screen and Parallax

If the right eye is higher behind the screen, there is a right hypertropia or

right hyperphoria. A prism is placed base down before the right eye, or base up before the left eye, until there is no movement.

As the patient sees the object move down, as the screen moves from the right eye to the left eye, there is a right parallax, and the prism which corrects the right hyperphoria should correct the right parallax.

Paradoxic or perverse screen and Parallax

A paradoxic or perverse screen and parallax test means that while the examiner observes an homonymous or esotropic movement of the visual axes, the patient sees the object move as in a heteronomous or exotropic movement. If diplopia is present, the false image is the opposite to what it should be when considering the position of the visual axes.

This is often seen in postoperative cases either for esotropia or exotropia, and usually indicates an anomalous retinal correspondence or faulty projection.

15 Park Avenue.

PHENOMENA ASSOCIATED WITH ECCENTRIC FIXATION*

A case report

George Guibor, M.D.
Chicago

In presenting this case report of eccentric fixation 11 points merit consideration. These will be grouped under three headings; namely, Motor phenomena, Visual phenomena, Proprioceptive phenomena.

J. K., a white boy aged eight years, was first seen at the Children's Memorial Hospital when eight months old, because of a right esotropia which had been noticed one month previously.

His birth was normal, but was followed by asphyxia, so that he was kept in an incubator for six days and received an injection of maternal blood.

Ophthalmic examinations

Examinations when he was one year old—on August 26, 1935, and on October 25, 1935—disclosed an alternating esotropia of 25 degrees associated with a defect in abduction (pseudoparalysis) of each eye. The retinoscopic examination while the eyes were influenced by atropine cycloplegia revealed an ametropia of: R.E. +7.25D. sph. ⌯ +0.25D. cyl. ax. 75° and L.E. +7.00D. sph. ⌯ +0.75D. cyl. ax. 120°. The lenses prescribed were R.E. +5.75D. sph. and L.E. +5.75D. sph. ⌯ +0.50D. cyl. ax. 120°. At this time the range of the abduction of the eyes began to improve under the influence of cycloplegia. The alternating esotropia became a right esotropia of 20 degrees with lenses and 30 degrees without lenses. The left eye was occluded four to six hours each day and one drop of atropine 0.25 percent was placed in the left eye once each day for one month. This treatment did not improve the right esotropia so that the squint remained, but varied from 30 to 50 degrees for one additional year. Fixation in the right eye was of oscillatory type. The eye was kept occluded constantly for an additional three weeks, during which period fixation ability of the right eye began to improve. Consequently the constant occlusion was continued for six weeks more.

* Presented before the Chicago Ophthalmologic Society, November 15, 1943.

At the age of 2½ years the patient was observed to be fixating with the right eye, whereas the left eye was converging 35 degrees without glasses and 20 degrees with lenses. Good abduction in each eye existed but left fixation was thought to be defective. Dr. Gamble, however, reported (on May 14, 1937), "I believe fixation is good in each eye. There is no limitation of abduction. I believe this was originally an alternating squint of pseudoparalytic type which has since become monocular."

Occlusion and atropinization of the right eye did not change the left esotropia. Changes in the glasses did not vary the left esotropia, even though a static retinoscopy revealed R.E. +8.50D. sph. and L.E. +8.00D. sph. ⊂⊃ +1.00D. cyl. ax. 73°. New lenses of R.E. +7.25D. sph. and L.E. +6.75D. sph. ⊂⊃ +1.00D. cyl. ax. 75° were ordered and received September 8, 1937, when the patient was three years of age. At this time the left esotropia varied from 40 to 50 degrees without glasses and 15 to 45 degrees with glasses.

Additional constant occlusion of the right eye did not improve the vision of the left eye (which was 20/100—1. The right visual acuity was 20/100. The vision in the right eye gradually improved to 20/20 while the left eye decreased to 3/200. The patient was then referred to the orthoptic clinic—on June 25, 1941—when he was first examined by the present writer.

At this time the patient was aged seven years. Unaided visual acuity was R.E. 20/20 : 14/14; L.E. 20/50 (?). Corrected visual acuity was R.E. 20/20 : 14/14; L.E. 3/200 : 3/140. There was an eccentric fixation in the left eye which converged 20 to 30 degrees with and without glasses, respectively, and remained fixating in the eccentric position when the fixating right eye was occluded. Additional occlusion and atropinization of the right eye did not influence the esotropia nor the fixation of the left eye. Five fundus examinations revealed no observable pathologic conditions in the optic nerve or macula.

It was decided to investigate the condition of eccentric fixation by means of the following aids: 1. The cover test. 2. The corneal-reflection test. 3. The motility test. 4. Induced diplopia. 5. Field studies. 6. Past-pointing and past-walking tests. 7. Correspondence test. 8. The electroencephalogram.

The techniques of most of these tests and the resulting findings obtained are demonstrated in the illustrations.

Discussion

The disturbances associated with eccentric fixation in this case may be studied under three groups: 1. Disturbances associated with the motor apparatus. 2. Disturbances associated with the visual apparatus. 3. Disturbances associated with the proprioceptive apparatus.

Disturbances associated with the motor apparatus

The deviation. The left esotropia of 20 arc degrees remained in the convergent position when the right, fixating eye was occluded (fig. 1, A). The esotropia persisted even when glasses of R.E. +7.00D. sph. and L.E. +7.00D. sph. were worn (fig. 1, B). In other words, the patient fixated with an area nasal to the true fovea (a condition often but erroneously called *false macula*). The deviation could not be measured by means of the cover test but only by means of the Hirschberg corneal-reflection test, because there was no movement of the left eye to fixate when the right eye was occluded.

Weakness in rotation. There was a slight weakness in the ability of the left external rectus to abduct the left eye outward, so that the temporal edge of the limbus did not touch the external canthus

(fig. 1, C). This condition was verified by the projection and induced diplopia. The induced diplopia caused by the vertical prism increased in the field of the weakened externus (fig. 1, D and E). This weakness was probably caused by an elongation of the left external rectus, produced by lack of visuo-motor impulses to this muscle—in other words, a slight atrophy of disuse. That this was not a true paralysis of the abducens nerve but a weakness of the muscle itself must be inferred from the history of the case.

Fig. 1 (Guibor). Phenomena associated with eccentric fixation (motor apparatus). A, left esotropia of 20 degrees without glasses. Eccentric fixation of left eye. Right eye occluded by card. Patient's eye fixating with extramacular area, object directly in front of him. B, left esotropia of 20 degrees with glasses persists when right eye is occluded by card. Patient's left eye fixating with extramacular area, object directly in front of him. C, limited abduction of the left eye—3 mm. of sclera visible temporally to left eye. D, subjective proof of muscle defect—10$^{\Delta}$ base down in front of right eye to produce a vertical (induced) diplopia. No horizontal diplopia in field of left internal rectus muscle. E, subjective proof of motor defect—diplopia is produced by 10$^{\Delta}$ base down, in field of left external rectus, verifies C.

Variations in electroencephalogram. The electroencephalogram demonstrated generalized increase in the cortical activity. This increased activity was irregular in character. The rhythm most frequently seen in this case was at the rate of 6 per second. There were other waves at the rate of 3 per second.

The total picture obtained from these data was that frequently seen in people who suffer from cryptogenic minor and major convulsions. This boy had no history of convulsive attacks at any time. The electroencephalogram, however, does not display any characteristics of known diagnostic importance in this case.

Disturbances associated with the visual apparatus

Amblyopia. When studying the disturbances exhibited by the visual apparatus in this patient with eccentric fixation, five characteristic changes were

found. The first of these was a loss of visual acuity (3/200 at distance and 3/140 at near). This severe type of amblyopia did not improve when the fixating eye was occluded constantly for four months; a fact that suggests that there may have been some atrophy of the neurons in the visual pathway even though this atrophy could not be ascertained by ophthalmoscopic examination.

Defective central visual field with normal peripheral fields. This defect in the visual pathway was demonstrated by a study of the central and peripheral fields, on the Ferree-Rand perimeter and near-field apparatus. Such a study showed the examiner that the second abnormal finding in the visual apparatus in this case of eccentric fixation consisted of a 5- to 7-degree absolute central scotoma associated with a normal peripheral field.

Normal projection but abnormal correspondence. Normal projection had been demonstrated by the induced-diplopia test (fig. 1, C, D). Here the patient had homonymous diplopia which increased as the left eye was rotated into the field of the weakened external rectus muscle.

The final evidence of abnormality in the visual apparatus was anomalous correspondence. In this test a vertical light is presented to the right eye only, for 20 seconds (fig. 2, A); and a horizontal light to the left eye for 20 seconds (fig. 2, B). The patient was asked to demonstrate the position of the afterimages as he saw them. With normal correspondence the patient superimposes the lights as a cross. It can be seen in figure 2, C that this patient with eccentric fixation did not see them as a cross but as if a space existed between the two afterimages. The right forefinger represents the vertical afterimage, the left forefinger the horizontal afterimage. The position of the two forefingers suggests anomalous correspondence. This fixed type of anomalous correspondence has never improved by any nonsurgical treatment which I have attempted. It may disappear if the eyes are corrected by surgery on the horizontal muscles.

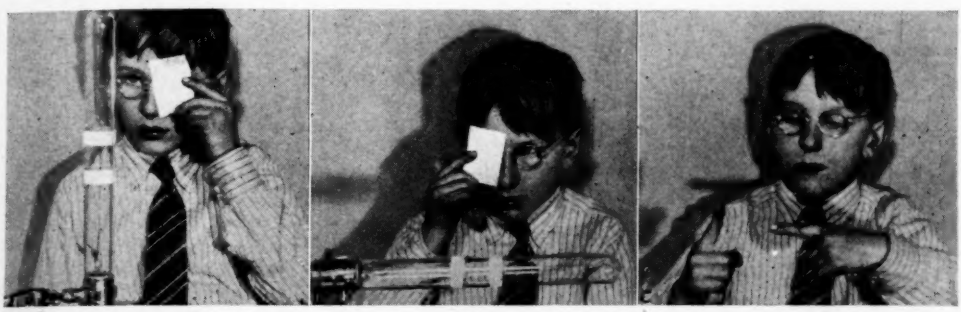

Fig. 2 (Guibor). Phenomena associated with eccentric fixation (visual apparatus). A, patient fixates with right eye a glowing vertical filament for 20 seconds. B, patient fixates with left eye (eccentric fixation) glowing horizontal filament 20 seconds. C, patient demonstrates with fingers apparent positions of afterimages (anomalous correspondence). Note binocular afterimages shifted toward patient's right.

Disturbances associated with the proprioceptive apparatus

Disturbances in the proprioceptive links between the extraocular mechanism and the proprioceptive pathways for the arms and legs were noticed by three objective manifestations—head rotation to the right, past pointing, and past walking when using the left eye.

Fig. 3 (Guibor). Phenomena associated with eccentric fixation (proprioceptive apparatus). A, second stage of pointing test. B, proprioceptive disorganization. Fixating with eccentric left eye. First stage of pointing test—patient still points toward the right of the object. He therefore past points to right. This verifies walking test for presence of proprioceptive disturbance. C, normal proprioceptive ability with right eye fixating. Patient walks on line successfully (suppressing left eye). Note rotation of head toward patient's right. D, right eye occluded, fixating with eccentric left eye, patient falls toward the right. E, proprioceptive disorganization in left eye. Patient walks toward right of white line, fixating with eccentric left eye. This verifies pointing test for presence of proprioceptive disturbance.

Head rotation. The head rotation toward the right certainly was not produced by diplopia, as the patient had such poor vision in the left eye that diplopia was impossible unless produced by a vertically placed prism. Therefore, the head rotation may be the result of proprioceptive impulses to the neck muscles from the eye muscles.

Past pointing. When pointing toward an object when he used the left eye he invariably failed to localize the object but pointed six inches to the right of the object (fig. 3, A and B).

Past walking. Normal walking, when the right eye was used, was disclosed by the fact that the patient could walk normally along a white line on the floor (fig. 3, C). Yet when the fixating right eye was occluded, the patient tended to fall toward the right (fig. 3, D). After regaining his equilibrium he attempted to follow the line but always walked toward his right (fig. 3, E).

Summary

The phenomena associated with eccentric fixation when studied intensively may be summarized under three headings: 1. Disturbances associated with the motor apparatus. 2. Disturbances associated with the visual apparatus. 3. Disturbances associated with the proprioceptive apparatus.

Disturbances associated with the motor apparatus may be said to be: 1. The esotropia. 2. The limitation of abduction (weakness in the left external rectus muscle). Induced homonymous diplopia which increased in the field of the left external rectus muscle. 3. Abnormal electroencephalogram.

Disturbances associated with the visual apparatus may be outlined as: 1. Amblyopia (3/200: 3/140). 2. A central scotoma. 3. Normal peripheral field. 4. Normal projection. 5. Abnormal correspondence.

Disturbances associated with the proprioceptive apparatus may be said to be illustrated by: 1. Head rotation. 2. Past pointing. 3. Past walking.

Note: Authorities do not agree that a proprioceptive apparatus is present in the extraocular-motor mechanism. Clinical evidence suggests that such a mechanism does exist.

30 North Michigan Avenue.

"BIASTIGMATISM"*

Evaluation and criticism of the refractive technique advocated by Márquez

Arthur Linksz, M.D.
New York
and
Wendell Triller, A.B., B.S.
Hanover, New Hampshire

Márquez's use of "bicylindric combinations in the exploration of astigmatism" was certainly one of the most interesting attempts to improve on the technique of refraction as it was performed at the beginning of this century. His publications on this subject, scattered over more than 30 years, appeared in Spanish and French, which is probably the reason why they have received but little attention in this country. It was therefore gratifying to have an English publication recently by Márquez himself[1] in which his basic ideas and his technique were given brief exposition.

Since many interested in refined refraction will have their attention called to Márquez's technique by the publication just mentioned, it seemed timely to investigate—and this has not been done heretofore—how this method compared, *in actual clinical practice,* with methods at present more widely used in this country, especially with a technique which we adopted under Dr. Lancaster's leadership during his stay at the Dartmouth Eye Institute.

Since Márquez's theory and procedures are now easily accessible to the American reader, we shall but briefly enumerate the principal points, using his own words as much as possible.

"Corneal" astigmatism, measured with the Javal-Schiötz ophthalmometer, or other similar instruments, often does not coincide with the "total" astigmatism, either in dioptric value or as regards the inclination of its meridians, since any of the other refringent surfaces may be deformed or not properly centered. Astigmatism can occur at the level of each of these surfaces. "Total" astigmatism is the result of the various possible partial astigmatisms. Theoretically there exists a mono-, bi-, tri-astigmatism or polyastigmatism.

"Biastigmatism" was singled out by Márquez because only the corneal astigmatism can be measured accurately, whereas astigmatism that is caused by other surfaces can be measured only *as a whole.*

Márquez pointed out correctly that this astigmatism should not be called "crystalline" astigmatism but should rather be referred to as "residual" astigmatism.

Now the combination of two astigmatisms is equivalent to a third astigmatism, consequently it has repeatedly been pointed out by critics of the Márquez procedure—which we shall outline presently—that the simplest and most preferable method is to determine, as is now generally done, this single "resulting" or "total" astigmatism by any of the subjective methods or by retinoscopy. Márquez's thesis, however, is that there are cases "in which it is precisely a matter of skillful clinical tactics not to do this, it being better to correct both astigmatisms successively in order to determine the total astigmatism more accurately."

This, precisely, is the refractive method

* From the Dartmouth Eye Institute, Dartmouth Medical School, Hanover, New Hampshire.

advocated by Márquez. He first measures, and by a proper cylinder in the trial frame, neutralizes the corneal astigmatism and then confronts the patient with an astigmatic dial. After proper fogging (Márquez calls it "myopizing"), if the radii of the dial should appear unequal (as they usually do), it is obvious that a second, a "residual" astigmatism is present. This he then determines by the subjective method of equalizing the spokes of the dial with cylinders in the usual way.

Thus, both the corneal and the residual astigmatism having been determined, Márquez proceeds to compute the resulting spherical error and the "total" or "resulting" astigmatism, which can be done by means of formulas, tables, or graphically.

Márquez, for some time, advocated the actual grinding of bicylindrical lenses, the corneal and the residual astigmatism being thus separately corrected by two cylinders ground on the anterior and posterior lens surfaces, respectively. We shall not discuss this procedure further. It is possible by this method—which Márquez holds to be advantageous—to arrive at sphero-cylindrical corrections of odd values which do not exist in the trial case, say 0.18 or 2.10 diopters. However, it has never been sufficiently proved that finer gradations than one fourths, or at most one eighths of a diopter are of any value in improving visual acuity or relieving symptoms of strain. As a matter of fact, very few patients are able to recognize any difference at all. The reader interested in this point is referred to Crisp's[2] pertinent remarks and a letter by Márquez[3] to the editor of this Journal.

The purpose of the investigation herein reported was, as has been stated, first of all to compare, in a number of cases, the results of the Márquez technique just outlined, with those of the fogging-and-dial method of Lancaster[4] and Regan.[5] The comparison of the results, especially the analysis of the differences encountered, revealed certain aspects of Márquez's technique not heretofore evaluated and, it seems to us, led to a more intelligent appreciation of its significance.

It seemed advantageous to have such an investigation made by two observers. First one of us (W. T.) determined the refractive error of the patients used in this study. A cycloplegic was not instilled. In his refractive technique Mr. Triller adhered to the procedure described by Lancaster and Regan as to fogging and other techniques. He then, however, usually checked the cylinder finally arrived at, both as to amount and axis, with the Jackson cross cylinder +0.25D. cyl. ⌯ −0.25D. cyl. or, in sensitive patients also with +0.12D. cyl. ⌯ −0.12D. cyl.

After determining a patient's refractive error, Mr. Triller measured the corneal astigmatism on the Zeiss keratometer and then turned the patient over to the senior author (A. L.), notifying the latter only of his findings on the keratometer. A. L. then determined the patient's refractive error according to the procedure recommended by Márquez, without knowing Mr. Triller's results beforehand.

Contrary to Márquez's suggestion, A. L. always used minus cylinders to neutralize the corneal astigmatism, regardless of whether the patient was myopic or hyperopic, and added minus or plus spheres, as the case necessitated, until proper fogging was obtained. Since, under proper fogging, any "residual" astigmatism naturally had to be corrected with minus cylinders, the exclusive use of minus cylinders for both purposes made the final computations simpler.

From the corneal astigmatism as measured on the keratometer and the residual astigmatism as determined on the astigmatic dial, we computed the patient's "to-

TABLE I*

DATA ON 34 PATIENTS TESTED FOR BIASTIGMATISM

(1) No.	(2) Corneal Astigmatism	(3) Residual Astigmatism	(4) Resulting Astigmatism	(5) Dial Astigmatism
1	−5.50 x 4*	−1.00 x 175	−6.40 x 2½	−6.50 x 2½
	−5.25 x 10	−1.25 x 20	−6.38 x 12	−6.50 x 12½
2	− .50 x 180	− .62 x 77½	− .27 x 53	− .25 x 70
	− .50 x 170	− .75 x 72½	− .30 x 60	− .25 x 70
3	−2.00 x 2	− .50 x 40	−2.17 x 8	−2.00 x 15
	−2.25 x 180	− .25 x 180	−2.50 x 180	−2.50 x 180
4	−2.25 x 175	− .75 x 20	−1.64 x 2	−1.50 x 180
	−1.50 x 170	− .50 x 60	−1.16 x 178	− .87 x 180
5	−3.75 x 20	−1.75 x 60	−4.48 x 32	−4.50 x 35
	−3.75 x 165	−1.50 x 130	−4.56 x 156	−4.50 x 162½
6	− .75 x 25	−1.37 x 105	− .72 x 95	− .50 x 90
	− .50 x 155	−1.00 x 65	− .50 x 65	− .50 x 90
7	− .37 x 180	− .50 x 65	− .38 x 41½	− .37 x 50
	− .25 x 45	− .87 x 90	− .91 x 82	− .75 x 85
8	−1.00 x 98	− .75 x 90	−1.73 x 95	−1.87 x 102½
	− .50 x 100	− .87 x 82	−1.32 x 88	−1.37 x 85
9	———	− .50 x 100	− .50 x 100	− .50 x 100
	−1.00 x 170	− .75 x 80	− .25 x 170	− .25 x 160
10	−1.00 x 150	−1.25 x 47½	− .54 x 23	− .25 x 10
	−1.75 x 180	−1.25 x 97½	− .62 x 165	− .50 x 160
11	−1.50 x 10	−1.25 x 95	− .37 x 29	− .25 x 10
	−1.75 x 170	− .62 x 90	−1.18 x 165	− .75 x 175
12	− .25 x 90	− .25 x 60	− .43 x 75	− .37 x 75
	− .50 x 90	− .12 x 130	− .54 x 97	− .50 x 95
13	———	− .50 x 90	− .50 x 90	− .50 x 90
	− .62 x 165	− .62 x 85	− .22 x 125	− .25 x 125
14	−2.00 x 12	− .37 x 45	−2.16 x 16½	−2.25 x 17½
	−2.50 x 160	− .62 x 162	−3.10 x 160½	−2.50 x 162½
15	−1.25 x 5	− .87 x 10	−2.13 x 7	−2.00 x 7½
	−1.50 x 10	− .75 x 42	−1.95 x 20	−1.12 x 175
16	− .62 x 20	− .37 x 50	− .87 x 31	− .75 x 45
	− .87 x 170	− .50 x 70	− .45 x 1	− .25 x 140
17	− .25 x 165	− .25 x 115	− .32 x 140	− .37 x 120
	− .25 x 180	− .25 x 157½	− .46 x 169	− .25 x 170
18	−1.37 x 155	− .75 x 67½	− .60 x 152	− .75 x 150
	−1.50 x 10	− .50 x 105	−1.00 x 8	−1.00 x 10
19	− .50 x 10	− .87 x 80	− .59 x 64	− .50 x 55
	− .50 x 140	− .25 x 60	− .28 x 131	− .50 x 120
20	−1.75 x 180	− .50 x 70	−1.40 x 7	− .75 x 10
	−2.25 x 180	− .25 x 180	−2.50 x 180	−2.00 x 2½
21	−1.50 x 140	− .37 x 50	−1.12 x 140	−1.00 x 140
	− .50 x 30	−1.12 x 80	−1.13 x 67½	−1.25 x 62½

TABLE I—*Continued*

(1) No.	(2) Corneal Astigmatism	(3) Residual Astigmatism	(4) Resulting Astigmatism	(5) Dial Astigmatism
22	− .75 x 170	− .75 x 92½	− .33 x 132½	− .12 x 120
	−1.00 x 175	− .50 x 57½	− .82 x 10	− .62 x 170
23	−1.50 x 180	− .75 x 85	− .76 x 5	− .50 x 100
	−1.25 x 170	− .62 x 100	− .87 x 157	− .50 x 135
24	−2.75 x 170	———	−2.75 x 170	−2.75 x 170
	−2.25 x 180	− .25 x 80	−2.03 x 1 *	−1.75 x 5
25	−1.87 x 170	− .12 x 80	−1.75 x 170	−1.75 x 175
	−1.25 x 180	− .25 x 80	−1.02 x 2½	− .75 x 10
26	− .75 x 170	− .37 x 55	− .57 x 4½	− .37 x 180
	− .50 x 180	− .50 x 105	− .25 x 145	− .37 x 140
27	− .50 x 160	− .50 x 65	− .09 x 22	− .25 x 40
	−2.00 x 170	− .87 x 82½	−1.11 x 166½	−1.00 x 165
28	−1.37 x 180	− .37 x 110	−1.11 x 174	−1.00 x 180
	−1.00 x 170	− .50 x 75	− .52 x 175	− .75 x 180
29	−1.00 x 170	− .25 x 40	−1.01 x 179	−1.00 x 180
	− .50 x 160	− .37 x 60	− .20 x 180	− .25 x 150
30	−2.75 x 165	− .37 x 140	−2.96 x 162½	−3.00 x 162½
	− .50 x 165	− .25 x 25	− .60 x 2½	− .50 x 180
31	−1.50 x 70	−1.25 x 112½	−2.02 x 89	−2.50 x 92½
	− .25 x 115	− .25 x 90	− .45 x 102½	− .37 x 105
32	−1.50 x 10	−1.25 x 102½	− .29 x 178½	− .50 x 175
	−2.25 x 10	−1.25 x 107½	−1.10 x 1½	−1.00 x 2½
33	−1.00 x 95	− .25 x 50	−1.03 x 88	−1.00 x 85
	− .25 x 165	− .25 x 150	− .49 x 157½	− .75 x 165
34	———	− .50 x 45	− .50 x 45	− .50 x 45
	− .25 x 180	− .25 x 120	− .25 x 150	− .25 x 140

"Corneal astigmatism" (column 2) indicates the astigmatism found with the keratometer (given in this table in the form of the neutralizing minus cylinder actually used in the trial frame).

"Residual astigmatism" (column 3) indicates the astigmatism found subjectively with the astigmatic dial after the corneal astigmatism had been neutralized.

"Resulting astigmatism" (column 4) is the total astigmatism arrived at by computation from the above values.

"Dial astigmatism" (column 5) is the total astigmatism arrived at subjectively by using the Lancaster-Regan dial.

Since the fogging technique has been used throughout this investigation, only minus cylinders were used regardless of whether the actual patient was myopic or hyperopic. The spherical values of the refractive corrections are not given in the table.

* In this, as in other columns, the data in the first line are from the right eye, those in the second line from the left eye.

tal" or "residual" astigmatism. The use of a graph published by the Bureau of Visual Science of the American Optical Company, in a pamphlet entitled "Transposition of obliquely crossed cylinders" was found to be most convenient for this purpose. Transpositions with this graph can be made easily, quickly, and with the amount of accuracy necessary for clinical purposes.

We refrained from any statistical analysis of the small group tested and prefer to publish, in the form of a table, the 34 cases examined in the described manner

(table 1). In this table, the spherical values of the refractive corrections are not given since it would merely have added to the volume of figures without in any way clarifying the problem.

Column 2 of table 1 gives the corneal astigmatism as determined by Mr. Triller.* We see no advantage in using the designation advocated by Márquez and all the findings are given in the form of the minus cylinders which were used in the trial frame at the time the residual astigmatism was determined, regardless of whether the patient was myopic or hyperopic.

In column 3 is given the "residual" astigmatism; that is, the minus cylinder that was found to be necessary in order that the properly "fogged" patient might equalize the lines of the dial after the corneal astigmatism had been neutralized.

Column 4 shows the "resulting" astigmatism which was computed from columns 2 and 3—that is, *the final astigmatic correction one arrives at when using the Márquez technique*—while column 5 gives the astigmatism as found by Mr. Triller in the same cases with his usual technique. As this astigmatism was determined by using the Lancaster and Regan dial, it is designated as "dial" astigmatism in the table.

If column 2 (the corneal astigmatism) is compared with column 4 (the resulting astigmatism as determined by the Márquez technique), it will certainly be seen that they differ considerably in a number of cases. The same is true if column 2 is compared with column 5. This is to be expected, since Jackson,[6] in his classical paper, showed that neither the amount nor the axis of the corneal and of the total astigmatism correspond in more than about one fourth of the cases.

The main purpose of this paper is now revealed in the comparison of columns 4 and 5 of table 1; that is, in the comparison of the astigmatism arrived at by the Márquez method with the astigmatism found in the same cases by using the fogging-and-dial technique advocated by Lancaster and Regan. If these two columns are compared, it must be admitted that there is a considerable number of cases in which the agreement is really remarkable, the more remarkable in view of the fact that the examinations were made by two different individuals and on an unselected group of patients who have never (at least most of them) been tested with an astigmatic dial before. (An analysis of the differences between the two findings will be given later.)

Convinced, as we are, of the superb accuracy of the Lancaster-Regan technique, any other refractive technique that compares favorably with this standard seems to us to deserve the greatest attention.

It is beyond question—and this comparison confirms it again—that the Márquez procedure has been a definite step forward in refractive technique from those older but still widely used procedures which it was meant to supplant and which based refractive correction on the corneal astigmatism, using, at most, Javal's rules of thumb to improve on it. Only when viewed against this background can the significance of Márquez's achievement be appreciated and if by "ordinary methods" he means these methods, Márquez certainly is justified in stating that he and his followers get "much more exact results—to the great benefit of their patients."

Nevertheless, further analysis of the Márquez technique in general, and of our data in particular, will reveal that as a method for routine examinations for the practitioner it cannot be classed with

* In this, as in the other columns, the data in the first line are from the right eye, those in the second line from the left eye.

either of the two subjective methods of refraction now prevailing in this country; namely, the fogging-and-dial, or the cross-cylinder technique.

First, to repeat one of Crisp's objections, the Márquez technique is cumbersome and unnecessarily complicated. It requires a longer time than the just-mentioned methods and a greater number of steps. It is first necessary to determine the corneal astigmatism. Then this must be followed by the subjective test on the astigmatic dial with careful fogging for any new amount of hyperopia that may have been artificially introduced, in case a minus cylinder was used to neutralize the corneal astigmatism. In addition, there is the computation of all three components: the cylinder, the sphere, and the axis of the final correction.

Of course, if, as Márquez still seems to believe, all these additional steps do provide an additional accuracy of refractive correction which could not be obtained by any other method, the Márquez procedure would still have to be regarded as the procedure of choice.

Hence the real question which must be answered in connection with the Márquez technique is: *Does this procedure provide any such accuracy as cannot be arrived at by other quicker and more convenient ones, especially by the fogging-and-dial or the cross-cylinder methods?*

To this end we shall have to analyze the individual steps involved in the Marquez procedure.

Both instruments used in connection with the Márquez technique, the keratometer and the dial, naturally are instruments of limited accuracy. In Márquez's own examples the corneal astigmatism is recorded up to the nearest quarter diopter and the nearest 5 degrees of axis, indicating that he neglects an error of ±0.12D. and of ±2.5 degrees, respectively. Even the best astigmatic dials, like those of Lancaster and Regan or of Friedenwald, have lines for every 10 degrees only. It is possible, if the astigmatism is not too small, to estimate its axis to the nearest 5 (in good observers 2.5) degrees. One thus takes into account a possible error of ±2.5 (±1.25) degrees. There is a further limitation of accuracy in the lenses of the trial case, especially on the European Continent, where fractions of one-eighth diopter are uncommon. Most patients with good visual acuity and not too high an astigmatism can differentiate on the dial between fourths of a diopter and many between eighths, if any such are in the trial case, leaving a margin of error of ±0.12D. or ±0.6D., respectively.

How, then, do unavoidable errors, due to the limited accuracy of the actual measurements, influence the computed results?

The first of these possible errors, obviously, may occur in the axis and the amount of the keratometer reading. Márquez apparently holds accurate keratometer readings to be of the greatest importance, his whole procedure being built around this value. An analysis of the actual procedure, however, will lead to quite different conclusions regarding this point.

The most convenient way of treating the optics involved in the correction of an astigmatic eye—as one of us (A. L.) has emphasized recently in another paper[7]—is to assume the presence of a cylinder of certain power and axis in the eye. The correction of the astigmatism then consists in finding that "glass"-cylinder of *opposite* sign which neutralizes the "eye"-cylinder; that is, the cylinder thought to be present in the eye.

The Márquez procedure can be analyzed most easily in the same manner. One assumes that there are two cylinders present in the eye (one representing the

corneal astigmatism, the other the residual astigmatism). Márquez's procedure will then consist in successively finding the two cylinders of opposite sign necessary to neutralize them. As we have used minus cylinders throughout our investigation and have always dealt with fogged (in Márquez's language "myopized") eyes, we shall choose the "eye" cylinders to be positive and the correcting cylinders negative.

As an arbitrary example let us take the following case: "Eye" cylinders: +2.00D. ax. 0° (corneal astigmatism) ⌯ +2.00D. ax. 60° (residual astigmatism).

The proper biastigmatic correction arrived at in successive steps in the Márquez procedure will be: −2.00D. cyl. ax. 0° ⌯ −2.00D. cyl. ax. 60° which, after computation (and neglecting the spherical element) will give for the total astigmatism: −2.00D. cyl. ax. 30°.

Now let us assume that an error as to axis of the corneal astigmatism of, say, 10 degrees had been made. (This is beyond that error which, in ordinary practice, would be expected to occur and is here chosen only to strengthen the argument.) Obviously the cylinder −2.00D. ax. 10° which is supposed to neutralize the corneal astigmatism, will not do so fully. From the combination: +2.00D. cyl. ax. 0° (the "real" corneal astigmatism) and −2.00D. cyl. ax. 10° (the wrongly placed neutralizing cylinder a "residual corneal" astigmatism of +.70D. ax. 140° will result. (The spherical component, which can be taken care of by proper fogging, is again neglected.)

Now the patient so corrected will be seated in front of the astigmatic dial, where he should indicate, by the subjective method, the value of his "residual" astigmatism. We supposed this to be (see above) +2.00D. ax. 60°, so that in case the corneal astigmatism had been fully corrected the examination on the astigmatic dial should result in −2.00D. cyl. ax. 60°. As, however, according to our previous assumption, there was an uncorrected residue of corneal astigmatism, the patient's "actual" residual astigmatism will be +.70D. ax. 140° ⌯ +2.00D. ax. 60°, which equals +1.40D. ax. 65°, and the correction for this "actual" residual astigmatism, revealed by the astigmatic dial subjectively, will (theoretically) be −1.40D. cyl. ax. 65°.

According to the Márquez procedure the patient's total astigmatism will now be computed from the two cylinders used. The first cylinder is −2.00D. ax. 10° (according to the astigmatism which was read erroneously from the keratometer); the second cylinder is −1.40D. ax. 65° (according to the "actual" residual astigmatism found on the astigmatic dial). The total correction found by computation from these two values will, nevertheless, be right; namely, −2.00D. cyl. ax. 30°.

We may go even further and postulate that not only the axis but also the amount of the corneal astigmatism was determined erroneously on the keratometer. To make our argument more valid we shall assume an error of 0.5D., which is much more than the one allowed for in clinical measurements. Both axis and amount of the corneal astigmatism being determined erroneously, the "glass" cylinder in the trial frame to neutralize it will be, say, −1.50D. ax. 170°.

Having assumed the "real" corneal astigmatism to be +2.00D. ax. 0°, the "residual corneal" astigmatism, due to improper neutralization, will be +.78D. ax. 20°. Assuming further, as we did, that the patient's "real" residual astigmatism is +2.00D. ax. 60°, on the astigmatic dial he will actually reveal an astigmatism different from this; namely, an astigmatism

that is the resultant of +.78D. ax. 20° ⌯ +2.00D. ax. 60°, equaling +2.26D. ax. 50°.

Obviously the correction found for this "actual" residual astigmatism on the astigmatic dial will (theoretically) be −2.26D. cyl. ax. 50°, and the total astigmatism, according to the Márquez procedure, will be arrived at by computation from −1.50 D. cyl. ax. 170° ⌯ −2.26D. cyl. ax. 50°, which again equals −2.00D. cyl. ax. 30°.

These computations have thus shown that no matter how erroneous may be the reading on the keratometer and the subsequently applied cylinder for neutralizing the corneal astigmatism, the astigmatic dial (*at least in theory*), will always reveal an "actual" residual astigmatism which, together with the erroneously determined corneal astigmatism, by computation, will give the patient's total astigmatism.

Summarizing this section of our discussion we may say that *the determination of the corneal astigmatism on the keratometer and its subsequent neutralization in the procedure according to Márquez, adds nothing to the accuracy of the determination of the patient's total astigmatism.* In other words, the Márquez procedure is as accurate as the astigmatic dial permits it to be, and if one arrives at satisfactory results with it at all this is due only to the use of the astigmatic dial, whereas preceding measurements on the keratometer have no part in them.

This we have also verified in patients. In a number of cases one of us (A. L.) has purposely turned the cylinder out of the proper axis, or applied, in the trial frame, a cylinder altogether different from that which would neutralize the patient's corneal astigmatism. Naturally, the "actual" residual astigmatism in every such experiment was different from the patient's "real" residual astigmatism. Nevertheless, the finally computed astigmatic correction (within limits of error inherent in such a procedure) remained the same.

In table 2 data from a few cases are given as an example. In these cases the "corneal astigmatism" was "neutralized" with a number of arbitrarily chosen cylinders, as can be seen from column 4. In column 5 the "actual" residual astigmatism, in column 6 the computed total astigmatism are given, while column 7 shows the astigmatism determined by Mr. Triller with the Lancaster-Regan dial.

An analysis of these data now reveals that though there is a close and definite resemblance between the data of columns 6 and 7, they still are not identical. As we have just seen, however, that the keratometer readings (the data in column 3 or 4) have no bearings upon the final result, the discrepancies can be blamed only on the limited accuracy of the astigmatic dial or on the limitations in available fractions of cylindrical lenses.

How, then—and this is our next problem—will this margin of error influence the computed final astigmatism?

In the paper quoted previously, one of us (A. L.) has shown how, by the laws of obliquely crossed cylinders, small errors in the axis of the correcting cylinder, in case its amount is correct or nearly correct, can produce a new astigmatism, small in absolute amount but with a characteristically large difference between its axis and that of the original astigmatism. Obviously the same laws govern the position of the axis of the resultant cylinder in the Márquez procedure, and one will have to expect large errors in the position of the axis of the total astigmatism in a certain group of cases which will be discussed presently. Curiously enough, Márquez repeatedly cited this very group of cases as that for which he asserts the

TABLE 2

DATA ON BIASTIGMATISM OBTAINED WHEN USING AN ARBITRARY CYLINDER

(1) No.	(2) Eye	(3) Corneal Astigmatism	(4) Arbitrary Cylinder in Trial Frame	(5) Residual Astigmatism	(6) Resulting Astigmatism	(7) Dial Astigmatism
10	R	−1.00 x 150		(a) −1.25 x 47½ (b) −1.00 x 50 (c) − .87 x 50	− .54 x 23 − .34 x 10 − .37 x 180	− .25 x 10
			−1.00 x 180 −1.00 x 120	− .62 x 90 −1.12 x 20	− .37 x 180 − .38 x 170	
	L	−1.75 x 180		(a) −1.25 x 97½ (b) −1.25 x 100 (c) −1.37 x 100	− .65 x 165 − .72 x 162 − .66 x 157½	− .50 x 160
			−1.75 x 150 −1.00 x 45 −1.00 x 135 −1.75 x 30	−1.37 x 52½ −1.25 x 142½ −1.12 x 30 −1.50 x 130	− .58 x 170 − .40 x 163 − .56 x 179 − .63 x 3	
24	R	−2.75 x 170			−2.75 x 170	−2.75 x 170
			−2.75 x 20 −2.75 x 180	−2.25 x 150 − .75 x 140	−3.25 x 178 −3.00 x 172½	
	L	−2.25 x 180		− .25 x 80	−2.03 x 1	−1.75 x 5
			−2.25 x 150	−2.25 x 30	−2.25 x 180	
32	R	−1.50 x 10		−1.25 x 102½	− .29 x 178½	− .50 x 175
			−1.50 x 170	−1.00 x 75	− .56 x 179	
	L	−2.25 x 10		−1.25 x 107½	−1.10 x 1½	−1.00 x 2½
			−2.25 x 160 −1.50 x 160	−1.50 x 55 −1.00 x 50	−1.20 x 179 − .98 x 1	

"Corneal astigmatism" (column 3) designates the astigmatism found with the keratometer (given in this table in the form of the neutralizing minus cylinder actually used in the trial frame).

"Arbitrary cylinder in trial frame" (column 4) designates a cylinder arbitrarily chosen in lieu of the one that would have actually neutralized corneal astigmatism.

"Residual astigmatism" (column 5) designates the astigmatism found subjectively with the astigmatic dial after a minus cylinder, as designated in Column 3 *or* 4 had been put into the trial frame.

"Resulting astigmatism" (column 6) is the total astigmatism arrived at by computation from the above values.

"Dial astigmatism" (column 7) is the total astigmatism arrived at subjectively by using the Lancaster-Regan dial.

The patient in case 10 has been tested on three different occasions, after neutralization of corneal astigmatism, and gave three slightly different values for "residual astigmatism" as indicated by (a), (b), and (c), which, of course, changed the value of the "resulting astigmatism."

advantage of his technique to be especially obvious.

It is the group of cases in which the corneal astigmatism is well-nigh neutralized by a residual astigmatism of nearly equal amount but opposite axis. The total astigmatism in such cases, obviously, is of small amount. Márquez's contention that this small astigmatism may be masked, so to speak, by astigmatic accommodation, we shall not now discuss as being beside the point in this connection.

As an example, we may consider a case in which the corneal astigmatism is −1.00D. ax. 0° and the residual astigmatism, say, −1.25D. ax. 90°. The resulting astigmatism will then be −.25D. ax. 90°. With the corneal astigmatism neutralized, we shall expect this patient to designate

the horizontal lines on the astigmatic dial as the blackest ones, indicating that the axis of his residual astigmatism is in the vertical.

Suppose, now, that the patient makes an error in his judgment of 5 degrees on the astigmatic dial (which, as has been discussed, is well within the limit of possible errors, especially for relatively small amounts of astigmatism), designating 85° as the axis of his residual astigmatism, the computation will give −.33D. ax. 69° (instead of −.25D. ax. 90°) as the value for his total astigmatism. Now suppose further, that in addition the patient makes the minor error (also well within the limitations of the method), of judging the amount of his residual astigmatism as −1.12D. (instead of −1.25D.), the total astigmatism as computed will be −.23D. ax. 58½°.

One can readily see the comparatively large differences, especially in axes, between these values. As such small errors as have been assumed are, however, within the limits of accuracy of the astigmatic dial and are therefore inevitable, it is impossible to decide by the Márquez technique which of the values is right. On the other hand, if one were to use the Lancaster-Regan technique in the same case, he would in most cases pick up the existence of a small astigmatism with axis somewhere in the vertical with no greater error than 10 degrees at most, on either side of the proper value; namely, −.25D. cyl. ax. 90°. In other words, there are at least certain cases in which the astigmatic dial loses accuracy when used in connection with Marquez's technique. The computation which must follow its use magnifies instead of telescoping, as Márquez thought, possible errors.

Our cases in table 1 show that this argument has not merely a theoretical value. Cases no. 2, 9 (left eye), 10 (right eye), 11 (right eye), 13 (left eye), 16 (left eye), 22 (right eye), 27 (right eye), 29 (left eye), 32 (right eye) belong to this group. Their corneal and residual astigmatism is nearly equal and the difference between their axes is around 90°. When comparing columns 4 and 5 one will readily see that the agreement between the two is poorest in these cases. Case 10 (see table 2) is of special interest in this connection, as we had an opportunity to recheck this patient twice after we became aware of the special problem involved in this type of case. One can see from table 2 that, with the same cylinder to neutralize her corneal astigmatism in the trial frame, this patient (on three different occasions) gave three slightly different readings on the astigmatic dial, all three well within the limits of possible error. Still, the computation of the total astigmatism according to Márquez's procedure furnishes three considerably different values (cf. lines (a), (b), and (c) in columns 5 and 6 of table 2).

In summarizing this section of our analysis, we may state that we thus have a certain group of eyes for which the Márquez technique is definitely unsuited. If, on the other hand, there is a majority of cases in which the Márquez technique gives excellent results, this only means, in the light of our analysis, that there is a majority of cases in which it lives up to the possibilities and the accuracy of the astigmatic dial. Our analysis, however, makes it clear that for intrinsic reasons the *accuracy of the Márquez technique* (being entirely dependent on the accuracy of the astigmatic dial, findings of the keratometer have no bearing on it) *can never be greater than that of the dial technique.*

Summary

1. The astigmatic error of an unselected group of 34 patients was determined with bicylindric combinations, as

recommended by Márquez in his numerous studies on "biastigmatism," and the results compared with those of the fogging-and-dial technique developed by Lancaster and Regan.

2. Analysis of the Márquez technique revealed that accuracy of measurements of the corneal astigmatism and its preliminary correction are irrelevant for the ultimately computed astigmatism, since any uncorrected corneal astigmatism is taken up by the residual astigmatism and revealed subjectively by the astigmatic dial.

3. The accuracy of the Márquez procedure is thus totally dependent on the accuracy of the astigmatic-dial technique and its limitations, whereas neutralization of the corneal astigmatism, as recommended by Márquez, adds nothing to it.

4. While the results of the Márquez procedure, in a majority of cases, compare favorably with those of the fogging-and-dial technique, there is a certain group of cases in which its accuracy is decidedly inferior.

5. The Márquez procedure is unquestionably superior to those older techniques which based the astigmatic correction chiefly on keratometer readings.

6. Since the Márquez procedure, even at its best, cannot furnish more accurate results than the direct use of the astigmatic dial, there is nothing that would recommend the adoption of this complicated technique for routine refractive examinations.

70 East Sixty-sixth Street, New York.
Dartmouth Eye Institute, Hanover.

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THE ENDOCRINE TREATMENT OF KERATOCONJUNCTIVITIS SICCA*

J. J. Fried, M.D., and Max. A. Goldzieher, M.D.
New York

Keratoconjunctivitis sicca, or Sjögren's disease, known for some years, used to be attributed to diminished lacrimation. The frequent association of deficient lacrimation and salivation with systemic manifestations, however, soon aroused a suspicion that the disease was not a purely local condition. A significant relationship with disorders of the endocrine system, especially a connection with ovarian deficiency, was mentioned by Fuchs. A survey of more recently observed material (Sjögren, Bruce, and Gifford *et al.*) bears out the earlier observation that most of the patients are of menopausal age (Isakowitz, Hauer), although the onset of their symptoms may have preceded the climacteric by many years (Lisch). The disease, at any rate, seems to be definitely sex linked, for it occurs with few exceptions only in the female. Gifford *et al.* recently reported 12 typical cases, 2 of which were in males whereas the 10 others were in women. An incomplete picture of the syndrome was observed in 21 other patients; this group included 5 males whereas the women in both groups were elderly, with the exception of 3 of childbearing age.

Symptoms which point to a systemic nature of the disease include dryness of the mucous membranes of the oral cavity, nasopharynx, sinuses, and larynx. Dryness and scaling of the skin were also observed. Arthritis affecting the extremities was mentioned by Sjögren in 17 of 22 cases; it was noted in one half of the material reported by Bruce.

Recent reviews (Bruce, Gifford *et al.*) have dealt in detail with the pathology, clinical symptomatology, and differential diagnosis of the disease. Referring in all these matters to these papers, our report is meant to discuss merely some therapeutic aspects of the disease in connection with a single case of keratoconjunctivitis sicca which was treated first in the orthodox ophthalmologic manner by one of us (J. J. F.); subsequently, in view of varied menopausal manifestations, the patient was studied and treated as an endocrine problem.

Case history

Mrs. E. S., 55 years of age, was first seen on November 9, 1940. Soreness of both eyes dated back to 1938; her condition, diagnosed earlier as keratitis, did not respond to any of the previously instituted treatments. She complained of a sensation of burning, comparable to the presence of a foreign body in the conjunctival sac. She was incapacitated for her work as a dressmaker. She also noted dryness in the nose, mouth, and throat. A luetic infection, acquired in 1930, had been energetically treated; Wassermann tests consistently negative since 1936, yet bismuth-salvarsan therapy had been administered every six months.

On examination, a high-grade, hypermetropic refraction (7 diopters) was found; visual acuity was 20/40; additional correction permitted reading of the smallest print (Jaeger 1) at 10 inches. A scanty mucous discharge exuded from the conjunctival sac in the form of long filaments. A dry velvety appearance replaced the usual glossy surface of the conjunctiva. The lower part of the cor-

*From the Department of Ophthalmology, Polyclinic Hospital, and the Endocrine Clinic, St. Clare's Hospital. Presented before the New York Society of Clinical Ophthalmology, February 7, 1944.

nea appeared to be irregular and lacking in its usual brightness. Epithelial shreds were pendant from the surface of foci of infiltration which were scattered all over the cornea. The conjunctival sac contained considerable threadlike debris.

A filter paper* left in touch with the conjunctiva for 40 seconds remained dry; this is in contrast to the normal eye which thoroughly wets filter paper up to a distance of 10 to 12 mm. within 40 seconds. Slitlamp examination after application of fluorescein to the eye showed faint staining of the lower part of the cornea as well as of the bulbar and palpebral conjunctiva; numerous small foci of infiltration on the surface of the cornea and a few faceted pits in the corneal epithelium were also noticed. The sensitivity of the cornea was well maintained. Except for pericorneal injection, the eyes appeared normal in all other respects.

The findings enumerated justified the diagnosis of keratoconjunctivitis sicca. Therapeutic measures instituted included: (1) Administration of vitamin A, orally and locally; (2) instillation of potassium iodide; (3) instillation of Locke's solution; (4) repeated irradiation of the tear glands with minimal stimulating doses of X rays.

As all these procedures were ineffectual, it was decided to close the lacrimal canaliculi by cauterization. The improvement obtained, however, was only temporary, for the ocular symptoms soon recurred in full severity in spite of the obliteration of tear drainage. As the dryness in the mouth, throat, and skin increased and became associated with lack of perspiration during the hottest summer weather as well as with an irritating vaginal itch, an endocrine study of the patient seemed desirable.

The patient, a short (61¾ inches tall) woman, weighed 163½ pounds (May 31, 1941). Except for some growth of hair on chin and cheeks, no physical abnormalities were found. Menstrual periods once normal had begun to diminish gradually seven years ago. An ovarian tumor (inflammatory?) had been removed 30 years previously. Vaginal examination revealed no abnormality except a slight discharge and redness of the labia. Vaginal smears showed the typical menopausal picture. Basal-metabolism rate −10; specific dynamic action of proteins considerably increased (26). Other laboratory findings included: a relative lymphocytosis of 40 percent and elevated values of glucose (119 mg. percent), uric acid (4.7 mg. percent), and cholesterol (261 mg. percent) in the blood.

Estrogenic therapy was instituted for the control of the vaginal itch, the general prurigo, and the dryness of the nasopharynx, without any definite expectation that this treatment might have an effect also on the condition of the eyes. The treatment consisted of oral administration of stilbestrol beginning with one milligram daily and injections of Progynon B (Schering), 4,000 R. U. twice weekly. The dosage of stilbestrol was gradually raised to 4 mg. daily until, at the end of the second week, the patient appeared to be relieved of the vaginal itch and general prurigo. No improvement of the eyes was noticeable at that time. The treatment was continued with decreasing dosage for three more weeks; finally, stilbestrol was replaced by estrone sulphate (Premarin), 2.5 mg. thrice daily, and the injection of Progynon B decreased to 4,000 R. U. weekly. Within less than two months after treatment was begun (August 1, 1941), the patient reported considerable improvement of her eyes. Subsequent reduction of estrogen intake was followed by a relapse, hence (September 12, 1941)

* Nitrazine paper strip, E. R. Squibb & Sons, New York.

stilbestrol was prescribed again, 2 mg. daily. Excellent response was noted within three weeks and confirmed by an ophthalmologic checkup. Subsequently, the patient was kept in good condition and able to work by continued stilbestrol therapy of varying dosage. Ophthalmologic examination on January 10, 1942, showed absence of all changes in the right eye and only insignificant residual changes in the left.

The patient was maintained, thereafter, on a daily dose of 0.5 mg. stilbestrol until June, 1942, when the vaginal itch recurred and simultaneously, also, the eye condition became worse. In spite of the immediate increase of the dosage of stilbestrol to 3 mg. daily, improvement was not nearly so satisfactory as previously upon the use of comparable quantities. Under these conditions, a therapeutic test with progesterone seemed indicated. Upon administration of 2 mg. progesterone, injected three times a week, definite improvement was soon noticed and complete regression of the condition was obtained after two weeks of this treatment. Thereafter patient remained well controlled on 1 mg. stilbestrol daily until January, 1943, when another mild relapse occurred which did not yield promptly to increased dosage of stilbestrol. Administration of progesterone again was strikingly effective just as on the first occasion.

Following continued stilbestrol maintenance the eye findings were again checked on September 10, 1943. At that time, lacrimation of the right eye was almost normal whereas that of the left eye was still defective. One small superficial epithelial lesion on the left cornea was visible with the slitlamp, whereas the right eye was normal to all appearances. These findings were corroborated by Dr. E. Torok who saw the patient in consultation on October 11, 1943. Dr. Torok had seen the patient previously (1939), at which time the condition was "approximately the same in both eyes."

Following another course of progesterone injection, combined with 3 mg. stilbestrol daily, further improvement of the left eye was obtained with the result that the patient's condition at the present time appears to be normal. Together with the changes of the conjunctiva and cornea, the dryness of the nasopharynx, the scaling and itching of the skin, and the pruritus of the vagina are well controlled.

Discussion

It is not permissible to draw far-reaching conclusions from therapeutic results obtained in a single case. Yet our observations are so striking and so well in accord with the endocrine background of this ophthalmologic disease, that a report of our findings seems justified.

It is well known that lack of ovarian hormones causes changes of the uterine and vaginal epithelium and also leads to atrophy of the epidermis (Goldzieher). In other cases, local foci of hyperkeratosis or scaling develop on the skin (keratoderma, Haxthausen), a condition which is attracting increasing attention. These changes yield satisfactorily to therapy with estrogens (Lynch), especially upon topical application. Similar claims have been made also in respect to the nasal mucosa, the atrophy of which was noted in hypogonad or menopausal cases (Mortimer *et al.*). Primary atrophy of the nasal mucosa with its onset before the age of 20 years improved in 86 percent of the cases; in secondary atrophic rhinitis, with its onset after the age of 20 years estrogenic therapy produced improvement in all cases so treated (Blaisdell). It is reasonable, therefore, to assume that a lack of sex hormones also induces atrophic or regressive changes on the epithelial lining of other mucous

membranes, not only on the vaginal and nasal epithelium or on the epidermis of the skin.

The systemic character of Sjögren's disease and its essentially sex-linked nature points in the direction of an ovarian hormonal factor. Their impression is strengthened by the preponderance of women at the climacteric age among patients affected with this disease. The incidence of keratoconjunctivitis sicca in women of childbearing age and, particularly, the few cases observed in males have discouraged serious investigation of the specific hormonal background. Previous attempts to treat patients with "estrogenic extract" (Gifford *et al.*) were apparently but half-hearted and too inadequate to be successful.

The incidence of the disease in women of childbearing age, at any rate, is no evidence against the pathogenetic significance of sex-hormone deficiency, for ovarian failure is not uncommonly met with in young women and expressed by more or less marked abnormalities of the menstrual cycle which may not necessarily come to the attention of the ophthalmologist. Nor does the rare incidence of the syndrome in males discredit the view that a deficiency of sex hormones is operative. Males and females produce estrogens as well as androgens, and deficiencies of hormone output are just as likely to occur in the male as in the female. It would be desirable to ascertain whether male patients afflicted with Sjögren's disease reveal clinical evidence of eunuchoidism or other signs of gonadal disorders. Assays of the urinary hormone output might contribute additional information. Even more desirable would be the therapeutic test, either with the male or female sex hormone in order to confirm or disprove its curative effect on male patients.

Summary

A case of keratoconjunctivitis sicca, observed over a period of three years is reported. Treatment with the standard ophthalmologic methods was unsuccessful. Remarkable improvement, practically amounting to a cure, was obtained by administration of estrogens. A relapse not controlled by increased dosage of estrogen yielded to added treatment with progesterone.

These observations confirm the belief that deficiency of sex hormones plays an important role in the pathogenesis of Sjögren's disease.

5 West Eighty-sixth Street (24)

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SEEING DEFECTS IN NONREADERS

MYRTLE MANN GILLETT, PH.D.*
Bryn Mawr, Pennsylvania

After 20 years of observing the way children behave, I believe that psychologic tests can be used to supplement the very simple routine eye tests that are used, because of limited funds, in most cities, for screening out the children who need examinations by specialists; moreover, if the eye charts are used as if they were educational tests, and if the child's behavior during the testing is interpreted in the same way as a psychologic examination, the reason why so many children do not learn to read, or learn only slowly, emerges clear and convincing.

The puzzle why backward children do learn to read when brighter ones do not, resolves itself, at least in part, when we find that the nonreaders do not see well enough to identify the printed symbols on the page. As a psychologist and teacher, I can merely report poor vision as a behavior response that I can appreciate and prove as such. Why the child does not see, whether the defect is physical, to be corrected by glasses or other medical means, whether the fault is irremediable, or to be changed by teaching because the measurable eye is "normal," is for the ophthalmologist to determine.

The conditions that I have found cannot be corrected by the means available to school teachers or psychologists. The defects that exist have not, so far, been reached by the teaching which has been successful with those who have learned to read. When medical science has had its say, then teaching methods can, perhaps, be devised for those few children who, according to the best medical opinion, should be able to see and yet do not. At present all reading methods for sighted persons seem to assume that the would-be learner sees adequately.

This report is not concerned with reading as the adult knows it, but with the elementary or beginning step; that is, the translation of the visual symbols into the thoughts which these symbols stand for and which the beginner already knows. No modern teacher attempts to teach any pupil to read what he cannot understand. Nor does the modern method fail to limit the quantities of reading matter to the apparent intelligence of the child.

Since this study covering 15 years was begun as a reading survey (with the aim of finding out, if possible, why these children did not learn to read), and since not all of the 2,500 received all of the tests which I eventually used, statistics cannot cover in all details the situation for each and every child. In the early years only such tests were given as seemed necessary to find out how to teach these children to read. Even toward the end the tests were never primarily measures of vision. I merely tried to find out whether or not the child could see clearly the material presented. This was true also when I made use of the simple eye charts with which every one is familiar.

The school medical reports for eyes in my city seem to be much like those of most large cities, my 2,500 nonreaders had been tested with the Snellen charts, the report being as usual a fraction indicating the visual acuity of each eye tested separately but never with both uncovered. In some cities this extra step is sometimes made so that there is some record as to how the child's two-eyed seeing compares with the conventional one-eye-at-a-time tests. Children with serious

* Supervisor, Special Education, Philadelphia Public Schools.

eye defects requiring instruction in sight-saving classes had with very few exceptions already been examined by the school ophthalmologist and therefore did not turn up among our nonreaders.

This unbelievably generous gentleman—busy though he was—gave so freely of his own time that many children whose parents refused to take them for eye examination were properly examined. These after wearing glasses learned so much better that it seemed well worth the effort to push on with the investigation, especially since some of the children who already had glasses were still nonreaders.

The material is vast but not all has been tabulated. So far, however, it points to the hope that with greater assistance from eye specialists there will be fewer nonreaders among adults than there are now, since teachers may be able to trust their own observations about their nonreaders before they have wasted long years of futile teaching and discouraging failure.

Through these school routine examinations the doctors had already found the nearsighted, although only 8 percent of the whole number of nonreaders were wearing glasses at the time of the psychologic examination. The school nurses were doing their best with the rest who apparently needed glasses. It is astonishing how antagonistic some parents are to all thought of glasses, and how long it takes even well-to-do parents to provide for eye examinations.

On the school medical cards 55 percent of the nonreaders were reported as having vision less than 15/15, but of course 15/20 would not necessarily indicate nearsightedness. In nonreaders the blur which gave less than 15/15 vision was in some cases shown to be not nearsightedness, but some other defect. Twenty percent of the nonreaders were marked on the medical card as having less than 15/30 vision for one or for both eyes, but during the depression glasses were too often not obtainable for children with eye defects less serious than 15/50 in both eyes.*

A nearsighted person who wears glasses knows that near objects appear larger to his eyes without his corrective glasses. Hence it would be likely that simple nearsightedness would usually not be a handicap for reading. It was possible to have 150 nonreaders whose eyes seemed equally nearsighted examined by an ophthalmologist, and in all of these cases it was reported back that other defects existed: "eyes on different planes," "astigmatism," "oblique eyes," "muscular atrophy" (quoted from the reports returned). Some of the defects were considered too small to require glasses, and some were labeled "mental defect," which I interpreted to mean some impairment in control which could not be measured, since all of these 150 had a Binet I.Q. above 90. (This I.Q. was given with not one lenient interpretation of the answers.)

Of 1,062 nonreaders in one group, 659 showed differences between the two eyes as against 159 on the school records with different fractional ratings for each eye, but only 65 of the 659 wore glasses, leaving 283 whose visual impressions must have departed from the normal.

In some cases these children whose eyes were different used one eye for distance and the other for nearer points. Sometimes the change over confused the images the child got, especially for print. Sometimes the struggle was quite clear

* Reports do not always make clear why glasses are ordered. Of 500 cases in 3 schools followed up for 2 years, 80 percent were given glasses immediately, 15 percent were asked to return later, 5 percent were supposed not to be "eye cases." These 500 cases were marked 15/15 15/15 on the medical card. "Muscular atrophy" (4.22) was reported on 3 of 25 cards returned on these 500 cases.

to even a not-so-professional observer.

Although we as teachers learn in school that at six years emmetropic children are able to accommodate to near vision, it was decidedly not so with some of these 2,500 nonreaders. The 15/15 vision of the medical record proved to represent not normal vision but farsightedness for which the routine examination made no provision and which the teacher was not taught to expect: du. .ng her school days she was not taught to differentiate between presbyopia and farsightedness; to her, farsightedness was a disease of old age. Teachers are not systematically taught, of course, about eyes.

Of the 1,587 children tested for seeing beyond 15 feet, 96 were too farsighted to see print in a book, and 286 more could not see ordinary print at 14 inches but could do so at from 3 to 10 feet. With the conventional charts the child could see the 15-foot line at 20, 30, 40, and in several cases at 60 feet. That is, large numbers of nonreaders were not yet adapted to reading easily at the normal distance or were, perhaps, never going to be.

To judge from the child's behavior, the greatest single difficulty for nonreaders seemed to be the failure to fuse properly the two images. We are told in school that fusion or proper coördination of "convergent eye movements is regulated by the unconscious desire for binocular vision"; however, unless the child has in some way learned that normal vision is not the blur he sees, it might very well be that he does not feel this desire for binocular (therefore, clearer) vision, inasmuch as one might conceivably not be able to strive for something of which one was completely unaware.

Among 1,062 (out of 2,500) nonreaders, 68 squint cases were reported at the routine examination. Could it be that only these 68 had made an adequate effort to eliminate one of the images? In certain tests 261 made no effort to converge, although no strabismus was discovered, rather did their eyes seem to remain, as it were, in parallel; 151 let one eye turn outward, more or less, as an object approached to 14 inches, although no squint was evident for ordinary distance. The rest of these children confused designs, shapes, figures, in such a way and so often as to give clear proof that they still saw two images, overlapped, or doubled images.

Including these 1,062, I tested 1,572 first as on the routine test one eye at a time, then with both eyes uncovered as one normally functions. Only 160 could see as well at 15 feet with both eyes as with each one alone; 153 could see with the two eyes as well as with the dominant eye if the vision in the two eyes tested alone was somewhat different but not seriously so.

In 545 cases wherein the eyes seemed to alternate badly, I tried to teach the child to converge properly, first by using a pencil; then by having him compare smaller designs with large ones that he could reproduce. Among these, 383 were unable, within the time allowed, to make any change. The rest varied in their effort, although they obviously knew what they were trying to do. These children systematically doubled and reversed in tests using numbers and letters (copied bird as brid, for instance.)

The psychologist has, of her own efforts, no way of knowing whether irregular convergent movements or poor control of the eye movements has been interfered with by cerebral lesions which we are told do lead to impairment of vision. The spasmodic activity seen in these nonreaders could not be analyzed; there was little time for history finding, and if parents were consulted they did not know of anything that might explain conditions. Paralysis of ocular or oculomotor nerves

was reported in several cases, history of diphtheria, and other serious illnesses; but since, in such cases, medical help was needed parents were told to seek the help of specialists. Mostly no reports came back.

One thing was clear: These children had not learned to see one image clearly, and would not be able to learn to do so merely with the help of a teacher who has 30 or 40 children to teach unless medical attention would make the eye behavior better. Routine eye examinations show very frequently changes in the record over a period of years so that a presumably normal pair of eyes may a year later show abnormal behavior. For example, the same doctor (not a specialist) in 1942 gets for the same child O.U. 15/15 vision, but in 1944, O.U. 15/30 or L.E. 15/30, R.E. 15/50; in 1939, O.U. 15/15, but in 1944, R.E. 15/70, L.E. 15/30, or a continued up-and-down history never explained and perhaps never corrected, probably because the parents think the child has good eyes or do not "believe in glasses." The psychologist's tests sometimes in the same week showed wide variations as if something (digestive upset, perhaps?) might temporarily have blurred the seeing. There was, of course, as a rule, no proof, since physicians can hardly be expected to render either a verbal or a written report these days, even in a worthy cause.

No psychologist would be willing to say that glasses will necessarily provide all the conditions needed for teaching nonreaders of this type. The cause is often obscure, apparently also sometimes to the medical observer; therefore the cure must sometimes be sought by trial and error even by the eye specialist who finds the correctible defect too small to seem to count, and by the teachers whose usually successful methods have no effect upon a child's learning.

Since teachers have no way of knowing, by their own tests, how far they may go in forcing a child to try to see, it would seem wiser for them not to develop "techniques" to force better use of the eyes by their pupils. Teachers can know that the child does not see clearly, but they cannot know whether or not the nonreader's vision is poor.

We cannot say that for the nonreader the teaching is poor until we know what the eye specialist thinks about the eyes. Nor can we assume that because the defect is not usually a hindrance that it is *not* one and perhaps the real cause of failure to learn. Neither teacher nor parent nor any one else should accept unquestioningly 15/15 for vision on a test chart as adequate proof that a nonreader has good vision.

We teachers and the school psychologist need the ophthalmologist—and badly.

Low Buildings.

NOTES, CASES, INSTRUMENTS

THE THERAPEUTIC USE OF CHOLINE IN OPHTHALMOLOGY*

THEODORE J. DIMITRY, M.D.
New Orleans

Although choline is a chemical of remarkable potency which has been basically studied (the research begun nearly a century ago, and complete reports have been made regarding it), nevertheless it had been almost completely disregarded as a therapeutic agent of merit for the treatment of certain ocular diseases in man to the time when this investigation was started some two years ago.

This contribution is not concerned with choline's therapeutic value in other organs than the eye and its appendages; however, it is submitted as a lead for others who may find choline therapeutically an arresting research problem.

Regarding its effect upon the lower animals, the biochemist, the biophysicist, and the biophysiologist have written volumes as to what happens when it is adopted experimentally. Its performance in their hands has been dramatic, and they describe what it accomplishes with arresting words.

Gyorgy[1] regards this agent's action as that of a vitamin. Lucas and Best[2] said that "choline should take its place with the other members of the B-complex, from which it cannot now legitimately be separated in any complete consideration of metabolic changes." It is also classed as a hormone by Mitchell.[3] Best and Ridout[4] consider choline to perform as a "lipotropic agent" and that choline, from the physical point of view, is a wetting agent. Besides, the mo' cule is both non-polar and polar according to Swan and White.[5]

Best and Lucas[6] "account for the voluminous literature on choline as due to the relationship of the substance to the ubiquitous phospholipids," yet with all the information at hand there are but few comments as to its use for man.

My initial experience with choline I credit to Dr. H. H. Beard, professor of biochemistry, Louisiana State University School of Medicine, who provided me with a well-grounded lead for the treatment of a lipoidosis and had me administer methionine to a young man who suffered from Spielmeyer-Vogt disease (juvenile amaurotic idiocy), a disease in which, according to Duke-Elder,[7] there exists a faulty lipoid metabolism, and for which treatment has been ineffective.

This amino acid, methionine, was discovered by Tucker and Eckstein[8] and found by them to possess lipotropic potency. Du Vigneaud et al.[9] offered the suggestion that methionine exerts its lipotropic action by contributing its methyl group for the synthesis of choline, a transmethylation reaction that they proved to occur. With this information at hand I adopted choline.

In this particular lipoidosis, that of the amaurotic idiot, the pathognomic vacuolated "foam" cells, accompanied by a lipoid degeneration, characterize the changes brought about in the central nervous system and the ganglion cells of the retina.

Both agents, namely methionine and choline, almost immediately accomplished the lowering of an extremely high temperature and a continuous epileptic spell that accompanied the disease, which otherwise was uncontrolled. I concluded therefore that choline and choline's pre-

*From the Department of Ophthalmology, Louisiana State University School of Medicine.

cursors were of benefit for at least certain occurrences in the abiotrophies of Sorsby.[10]

I carried out my investigation further so as to note choline's potency in the treatment of other diseases, and, as a consequence, adopted choline for the treatment of xanthoma planum, supposedly a purely cholesterol infiltration of the skin. The yellow blotches faded in approximately four to five weeks after the ingestion of choline, 5 grains three times daily. Sterner[11] had suggested that choline would hasten reabsorption of these plaques. This it did under my observation. Best and Ridout[4] had shown "that the feeding of choline prevented the deposition of neutral fat and to a lesser extent that of the cholesterol esters in the livers of animals receiving pure cholesterol in their diet." It thus appears that choline was involved in the metabolism of cholesterol as well as that of the lipoids.

My therapeutic investigation of choline was continued to discover whether it would influence an exophthalmos. The patient's proptosed eye had not receded after a goiter operation; however, when choline was used it did recede, and again the effect was credited to a lipotropic action.

Case 4 was that of a young woman, 21 years of age, who developed a tuberculous retinal perivasculitis following a biopsy for a lupus of the face. The tubercles disappeared within a few weeks and the multiple retinal hemorrhages, concurrent with the disease, were arrested and became absorbed. In another case, a tuberculous retinochoroiditis with a large nodule was not benefited by choline. It was at this time that I began to study the action of choline on the leper. Such work, however, has been very limited and incomplete and one hesitates to make any statement regarding it.

The need of choline in cases of certain pathologic changes has been established in the rat by others. Lower animals that suffer a choline avitaminosis develop fatty kidneys and kidney hemorrhages. Both conditions subside on the administration of choline. Perlman, Rubens, and Chaikoff[12] state that "choline had an antihemorrhagic effect and this was seen in tissues other than the kidneys."

The tuberculous child in this report, as also the tuberculous woman, gained weight and the child's growth apparently was accelerated. Weight increase and body growth are characteristic therapeutic effects of choline. MacLeod,[13] while studying insulin, also observed this remarkable nutritive factor of choline.

Then, for the time being, I digressed to consider choline's effect when instilled into the conjunctival cul-de-sac, when injected subconjunctivally, and when applied in the pure state to corneal ulcers and vascular loops, and again in every conceivable type of tissue pathology where I suspected lipoids and cholesterol crystals might be present in consequence of previous disease conditions or traumas. We have produced mustard-gas lesions of the eye in rabbits, the pathology of which is familiar through the writings of Mann and Pullinger.[14] It was natural to try to remove the fats and cholesterin. Choline accomplished this feat.

It was discovered that choline, 5 gr. to the ounce of water, could be used to irrigate the conjunctival cul-de-sacs and without the slightest irritation. It acted as one would wish a perfect pH to do and it could be adopted indefinitely for such a purpose.

I observed that choline was a wetting agent and that dry cicatricial pemphigus mucous membrane could be moistened and that choline had an effect upon the

pathologic change. From the demonstration upon the dry tissue of pemphigus and the effect upon the pathologic change I began to argue that choline may be an enzyme. Strack[15] and his collaborators showed "that certain lesions, notably liver and placenta, possess enzymes which liberate choline rapidly from phospholipids." I knew by laboratory tests that choline had some antiseptic value and would bleach tissues, remove scabs, and when rubbed on the face had vanishing qualities. As a dentifrice it had no peer.

Choline when applied pure at the end of a match stick to a moderate-size ulcer of the cornea proves to be a strong detergent, for when so applied the base of the ulcer comes to present a limpid appearance.

The greatest of my surprises came when I observed that choline would affect the diseased eyelashes of trichiasis, and that epilation was found to be unnecessary. Naturally, I concluded that the pathology of trichiasis was a diseased root in which fats and cholesterols were factors to be removed before the lash could grow properly.

Choline is definitely known to be a strong base; its solutions dissolve fibrin, and it does not coagulate the proteins. I have had but a most limited opportunity to give choline a trial in the epidemic form of superficial punctate keratitis. In the limited experience I have had, it appears to be beneficial both locally and as a nutritional factor.

A statistical study will not be presented here as to the effect of choline upon cataract other than to make the statement that it does not affect mature cataract and has very little, if any, effect upon incipient cataract. However little effect it may have, its potency is greater than that of vitamin B_2.

Choline does have a definite effect upon the general nutritional condition of many patients suffering from cataracts.

It should be stated that choline's molecule is both polar and nonpolar and when the radical is combined with certain antiseptics greater than itself, they are carried deep into the tissues.

The case of pterygium is not as Duke-Elder would have it, in that "the only treatment is surgical," but pterygium is the result of an avitaminosis in which choline affects the growth no matter how it is administered—internally, when used as an eyewash, or when applied directly to the pterygium's head in crystal form by means of a toothpick. The islets of Fuchs, which are of lipoid and cholesterol bodies, fade. Choline produces a reversal in these fatty bodies.

In conclusion: Choline is a therapeutic agent of merit when adopted for the treatment of the eye and its appendages. Unquestionably it is a great dietary factor and is a lipotropic agent. The phospholipids and cholesterol deposits following pathologic changes in the eye are reversed, thereby altering the nutrition of the cell, whether choline is taken internally or applied externally.

It has an effect upon tubercles, leprous, or otherwise. Physically it is both a polar and nonpolar compound, thereby highly soluble in lipoids and in water. Because of these characteristics it has great tissue-penetrating powers, whether alone or in combination with chemicals.

Its effect can be demonstrated dramatically. A crystal of choline dissolves in fats and in water. It can be put into the eye in natural form, instilled in solution, or applied as an ointment without producing pain. Witness the immediate action of a few crystals when placed on the head of a pterygium, the action when injected into a pterygium, and note what happens to the pterygium when choline

is taken orally for a few weeks. Note its effect upon ulcers of the cornea, and on new blood-vessel formation at the limbus. Finally, note that its solution has a high dielectric constant, containing a charged group.

1542 Tulane Avenue.

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BILATERAL CATARACT EXTRACTION IN ANTERIOR MEGALOPHTHALMOS

Hugh C. Donahue, M.D.
Boston

The clinical syndrome recognized as "Adult hereditary anterior megalophthalmos sine glaucoma" has been observed and reported by ophthalmologists for approximately 75 years; successful bilateral cataract extraction in this condition, however, has never been reported; indeed, unilateral cataract removal has encountered frequent complications and successful results have comprised less than 55 percent of the total number of cases cited in the literature in which operation was performed.

The entity now described as anterior hereditary megalophthalmos sine glaucoma is one of exceeding interest, both because of its pathologic characteristics and its challenge to the ophthalmic surgeon to produce visual improvement for such individuals as possess this rare condition complicated by cataract. The syndrome consists of bilateral enlarged corneas, occurring practically always in males as an hereditary sex-linked characteristic, coupled with deep anterior chambers, iris atrophy and iridodonesis, and absence of all evidence of glaucoma; there may occur embryotoxon or arcus senilis, dislocation of the lens, which may or may not be cataractous, and miosis of the pupil resulting from iris atrophy.

The etiology of anterior hereditary megalophthalmos sine glaucoma is not clear; the subject was adequately reviewed by Vail in 1931, and the literature reveals very little new evidence since that time, although various authors have reported cases, some being, however, examples of megalocornea without the additional characteristics of anterior

megalophthalmos. Some of the causative theories advanced for the condition are: (1) that it is an anomalous type of buphthalmos; (2) that it is a manifestation of atavism, as in mammals other than man the cornea is much larger in proportion to the size of the entire globe; (3) that it is due to endocrine-gland disturbance, producing overgrowth of the involved tissues; and (4) that it is an inherited form of tissue hyperplasia accompanied by later degenerative changes in the anterior segment of the eyeball. All these ideas are conjectural and have not been proved by complete pathologic findings, but it would seem most probable, in the light of present information, to regard the syndrome as an hereditary phenomenon, sex-linked, producing overgrowth of the anterior covering of the eyeball followed by secondary degenerative changes in the iris and lens.

In a large percentage of these cases cataract occurs, and as the hazards of operation are substantially greater and the results reported not particularly impressive it was deemed to be of interest to record a case in which bilateral cataract extraction was performed followed by rather unusual sequelae and ultimate good vision to the present date of observation. A review of the literature reveals that in approximately one third of the cases of megalophthalmos, cataract occurs, but it should be emphasized again that some observers have not distinguished between megalophthalmos and megalocornea in reports, whereas the conditions constituting anterior megalophthalmos—that is, iris atrophy, iridodonesis, and changes in the lens zonular fibers—all create a much more hazardous situation for cataract extraction than a condition of megalocornea alone. In the available reports of patients who have been operated on, in many instances the type of lens opacity is not definitely stated, but in those reviewed about 80 percent were either mature or hypermature in degree and nuclear or cortical in type.

All varieties of surgical procedures have been attempted in the technique of delivery of the lens; some surgeons have done no iridectomy while others have performed a preliminary iridectomy; some have utilized sutures, others have not. The cataract has been extracted with a needle, spoon, or following stripping of the capsule with forceps; in 85 percent of cases there was loss of vitreous, and in over 60 percent of cases there ensued postoperative complications such as separation of the retina, glaucoma, iridocyclitis, and persistent opacities in the vitreous. It seems probable that each surgeon utilized the technique most familiar to him and to the era contemporary to him in operating on these patients rather than endeavoring to apply a surgical approach and method more applicable to the pathologic changes to be encountered. Results have not been startling nor remarkably beneficial to the patient. For these reasons when the opportunity presented itself to me to essay cataract extraction in this abnormal condition, several points of caution concerning operation came to mind; first, insertion of three corneoscleral-tract sutures seemed desirable to insure firmer and more secure healing of the wound and less likelihood of iris or vitreous prolapse; second, removal of the lens in capsule was of paramount importance to forestall any complication due to remaining lens remnants; any procedure involving stripping of the capsule was to be avoided, as the literature showed that practically all such surgical procedures ended in disaster; third, insistence upon a slow and gradual convalescence from operation, especially with reference to getting up and around, was necessary, to allay possibilities of retinal separation; fourth, extraordinary preop-

erative conjunctival antisepsis and sedation for the patient seemed highly desirable for production of ideal operating conditions.

With these thoughts in mind bilateral cataract extraction was performed upon a 49-year-old male with anterior megalophthalmos as described below; following each operation there were several weeks in which occurred recurrent hyphema and vitreous hemorrhage notwithstanding all the precautions observed. Eventual complete absorption of the hemorrhage took place, however, with the procurement of clear media and normal fundi. Vision with lenses in each eye equals 20/30, and the patient is delighted and astonished with the result; of course, it is obvious that the postoperative period is relatively short and that unwelcome complications may yet take place, but to the present date of observation such a result following bilateral cataract extraction in anterior megalophthalmos is rare indeed.

Case Report

Mr. J. B., aged 49 years, single, a laborer of American parentage, was first seen by me in January of 1941. At that time he stated that his vision had never been good during the entire course of his lifetime. During the previous six months, it had, however, become progressively worse and had recently reached the point where he was unable to carry on his occupation or to read ordinary news print.

He had had no previous eye disease but had worn glasses from childhood. The patient was one of seven children and was the only member of the family who had abnormal eyes or poor vision. He was of average intelligence, had progressed satisfactorily in school, and apparently was alert and mentally normal. There was no history of consanguinity in the family. He stated, however, that his eyes had always been extraordinarily large but that he had been able to carry on his work, and that his general health had always been excellent.

Examination revealed vision in the right eye to be 6/200. The lids and conjunctiva were normal. The cornea was clear centrally, although there was marked arcus senilis. The cornea was perfectly transparent but appeared similar to a large inverted bowl. The anterior chamber was very deep and the pupil was irregular in shape, approximately 3 mm. in diameter, and reacted sluggishly to light. There was marked atrophy of the iris, with absence of chromatophores and crypts. An extreme degree of iridodonesis was present upon movement of the eyeball. A nearly mature nuclear and cortical cataract was present. There was normal projection of light in all quadrants and tension was 14 mm. Hg with a Souter tonometer. It was impossible to improve the patient's vision with any lens. Measurement of the cornea revealed the horizontal diameter to be 14½ mm., whereas the vertical diameter measured 14 mm. (figs. 1, 2).

Examination of the left eye revealed vision to be 4/200. The cornea was also bowllike in appearance, transparent and clear centrally, with an extreme amount of arcus senilis. The anterior chamber was very deep and clear. There was also extreme lack of pigment cells in the iris, with absence of crypts. The pupil reacted to light slightly better than did the right eye, but was also irregular in shape and about 3 mm. in diameter. The amount of iridodonesis was very marked upon movement of the eye, and a nearly mature cataract of nuclear and cortical type was present. There was normal projection of light in all fields, and tension was 12 mm. Hg with the Souter tonometer. Vision was unimproved with any lens; measurement of the cornea showed the horizontal di-

ameter to be 14 mm. whereas the vertical was 13.5 mm.

Examination of the right eye with the slitlamp revealed the central cornea to be clear and transparent. The epithelium was entirely normal. There were no striations nor folds in Descemet's membrane. The posterior cornea showed no precipitates. The iris stroma showed extreme atrophy with absence of pigment cells and no formation of crypts. The iris blood vessels seemed to be contracted and smaller than normal and there was a moth-eaten, threadbare appearance of the iris around the mid-stroma to the sphincter margin, with absence of pigment. The nuclear portion of the lens showed some accumulation of brownish pigment on the surface. The results of slitlamp examination of the left eye were essentially those of the right.

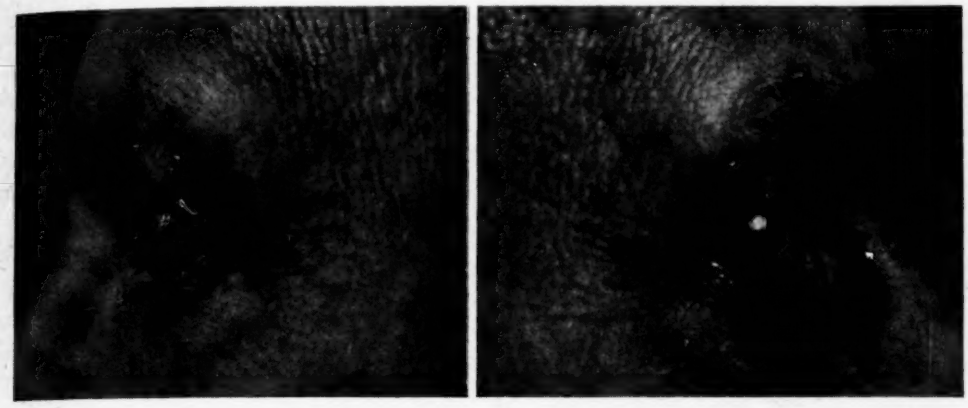

Fig. 1 (Donahue). Anterior megalophthalmos—lateral view.

Fig. 2 (Donahue). Anterior megalophthalmos—anterior-posterior view.

In March, following a period of antiseptic treatment to the conjunctival sac, operation was performed by me upon the left eye. Following akinesia by the Van Lint method and retrobulbar injection, three corneoscleral-tract sutures were inserted after the method

of Verhoeff. An incision from the 10:00- to the 2:00-o'clock position was made, following which there was a profuse outflow of aqueous with pronounced collapse of the cornea. The extremely large cornea became inverted and wrinkled and there was a mushy softness of the eyeball with sinking backward of the lens opacity. Enlargement of the section on either side was done with scissors, and it was possible to rethread the tracts rather easily. The atrophic iris was grasped at the 12:00-o'clock position and iridectomy performed. Because of the above-described soft condition of the eye, however, it was difficult to grasp the lens, for visibility was poor owing to the collapsed eyeball and the extreme degree of downward prolapse of the cataract. However, attempts were made to grasp the lens at the equator without success, and fearing that the lens might be further pushed back by additional manipulation, I decided to remove it with the wire scoop. This was easily done, with the loss of a very little fluid vitreous; following this, the sutures were tied and the iris pillars reposited.

The lens was of normal size, of the cataracta nigra type, and a rather unusual finding was that, attached to the posterior pole was a strand of tenacious, stringy vitreous approximately one-half inch in length. Such an attachment of vitreous to the lens had never occurred before in my experience and it presented quite an extraordinary sight. No complications occurred followed delivery of the lens and the patient was returned to his room in good condition.

For the following five days, convalescence was uneventful but, upon the sixth day, considerable bleeding into the anterior chamber took place, resulting in a 5-mm. hyphema. Upon the next day, the anterior chamber was completely filled with blood and there was no visible red fundus reflex. No change in this condition ensued for the next week, although various antihemorrhagic and anticoagulant forms of therapy were employed together with absolute rest in bed and local treatment to the eye. There was no increase in intraocular pressure at any time. Following a three-week postoperative stay in the hospital during which very little absorption of the anterior-chamber hemorrhage occurred, the patient was discharged to return home, but to report to the office for observation and treatment.

Ten days after hospital discharge, observation in the office showed a great decrease in the amount of blood in the anterior chamber, with concurrent absorption of vitreous hemorrhage so that a red reflex could be obtained upon examination with the ophthalmoscope. Large strands of organized hemorrhages could be seen in the fundus. Two weeks later this blood had become absorbed to a greater degree, and two months following hospital discharge the media were entirely clear, with the exception of a few vitreous opacities. The fundus could easily be seen and showed nothing abnormal, with the exception of scattered degenerative retinal changes due to long-standing myopia.

Fourteen weeks after operation, correction of the patient's operated-on eye with a +1.00D. sphere gave vision of 20/30. This result was extremely gratifying to him, and he was astonished to possess as much vision, never having experienced any comparable amount of sight. He returned to his occupation. Six months later I performed the same type of operation upon his right eye. Oddy enough, the same course of events followed operation on this eye by the use of the same methods as those described for the other eye. Massive hyphema and vitreous hemorrhage which persisted for six to eight weeks following operation gradually cleared up.

Because of the previous experience with intraocular hemorrhage, I had conferred with medical consultants concerning such bleeding and all the current types of antihemorrhage therapy were employed without success. The intraocular blood took approximately eight weeks to become absorbed. The media and fundus showed no pathologic changes 10 weeks after operation, with the exception of myopic retinal changes. A +2D. sphere with a +2.50D. cylinder, axis 165° produced 20/30−3 vision, and the patient was able to read Jaeger 1 print with the addition of a +2.00D. sphere to both lenses.

This man has been seen at intervals during the past 20 months and no untoward complications have occurred. It is very apparent that the postoperative period has been relatively short; notwithstanding this fact such a result to date is extremely gratifying and beneficial to an individual suffering from anterior megalophthalmos complicated by nearly mature lens opacities, and is uncommon in surgery of the eye.

Summary

A case of anterior megalophthalmos in which successful bilateral cataract extraction was performed, is described. A description of the syndrome, itself, as well as some additional data concerning cataract extraction in this condition are presented.

520 Commonwealth Avenue.

SOCIETY PROCEEDINGS

EDITED BY DR. DONALD J. LYLE

CHICAGO OPHTHALMOLOGICAL SOCIETY

March 15, 1943

DR. LOUIS G. HOFFMAN, *president*

CLINICAL PROGRAM

(Presented by the Department of Ophthalmology, Cook County Hospital

DEEP CENTRAL CHORIORETINITIS

DR. RALPH SIEGEL said that C. A., a man aged 46 years, was first seen in the Eye Clinic on February 25, 1943, one week after he noticed sudden marked blurring of vision in the right eye, not accompanied by pain.

Corrected vision, R.E., was reduced to 0.2. The disc was normal, but in the macular and paramacular areas there was a gray, dome-shaped elevation measuring about 3.0 P.D., with a sharply defined nasal border starting abruptly, three vessel diameters temporal to the disc. The temporal border of the lesion was not sharp. Superior to the center of the elevation and above the macular area was a 0.5-P.D. patch with pigmentation in the shape of a cross. The left eye was normal in all respects; corrected vision, 1.2.

Peripheral fields of the right eye showed moderate concentric contraction and an irregular central scotoma for isopter 3/330 white. Central fields showed a 12-degree central scotoma for isopter 5/1,000 and an absolute central scotoma for red and blue, 5/1,000.

Blood Wassermann, Mantoux, and chest X-ray study showed negative results. No focus of infection was found on physical examination.

Three days ago the nasal border of the lesion appeared flat, and the retinal edema subsided. The corrected vision, R.E., is now 0.5.

TRAUMATIC COLOBOMA: HUGHES OPERATION

DR. RALPH SIEGEL said that H. L., a man aged 39 years, came to the Eye Clinic on September 6, 1942, with a traumatic coloboma of most of the left upper lid due to a human bite which had occurred a few hours prior to admission.

A moist chamber was used for several days, followed by a Friedenwald suture, which prevented damage to the cornea by exposure. On October 16th, when infection of the wound edges had subsided, a modified Hughes operation and skin graft were performed. A horizontal incision was made below the brow and the skin of the upper lid was undermined. The lower lid was split transversely into two layers, starting along the intermarginal white line and dissecting downward. The upper epithelial border of the lower tarsus was cut off and this was united to the remains of tarsus and the deep portion of what remained of the upper lid. The previously undermined skin of the upper lid was drawn downward and attached to the freshened skin margin of the lower lid by two intermarginal sutures. The remaining defect beneath the brow was filled in with a full-thickness graft taken from the right upper lid.

On November 13th there was some contraction of the skin graft and a Thiersch graft from the thigh was used to fill in the defect below the left brow. A transverse trough was dissected below the intermarginal adhesion line at this time, and a strip of hairs was excised from the left temple and transplanted

in position to form lashes; another lash transplant was performed on January 29th.

The patient now has a fully reconstructed upper lid with a luxuriant growth of lashes, and needs only an opening of the intermarginal adhesions.

Neuroretinitis papulosa

Dr. R. H. Lehner presented B. S., a Negro aged 25 years, who was first seen on January 9, 1943, with a history of having been kicked in the right eye by a horse at the age of 8 years, following which most of the vision in that eye was lost. Six years ago the vision of the other eye began to fail. Vision, R.E., 18/200, with correction 20/100; L.E., 20/200 with or without correction.

In 1937, because of positive serologic findings, he was placed on antisyphilitic therapy, and the blood test is now negative.

In the right eye the lens is dislocated down and inward; a central opacity is present just anterior to the adult nucleus with a fine dustlike opacity surrounding the entire nucleus. There is a fairly recent small area of choroiditis just inferior to the macula. The left disc is slightly pale; there are large areas of chorioretinitis which include the macula; connective tissue extends along the veins, and a connective-tissue strand horizontally below the disc from the macular area to the nasal area of chorioretinitis.

The presence of the connective-tissue strands below the disc, the periphlebitis, the postneuritic atrophy, and the disseminated chorioretinitis point to the diagnosis of neuroretinitis papulosa.

Chorioretinitis with retinitic atrophy and choroidal sclerosis

Dr. R. H. Lehner said that J. T., a man aged 50 years, was first seen on February 11th with a history of blindness in the right eye for 45 years, and poor vision in the left eye for the past two and a half years. Vision, R.E., 10/200; L.E., 20/200. In spite of vigorous antisyphilitic therapy since 1939, the blood test has remained positive.

The fundus of the right eye shows a pale well-demarcated disc with complete absence of retinal pigment except at the periphery. The fundus is of a pale-yellow color and the choroidal vessels are sclerotic. In the left eye there are dense posterior synechiae, with organized exudate over the anterior lens capsule, partly obscuring the fundus reflex.

Cystic lesion of macula

Dr. Jack E. Brooks presented R. C., a Negro boy, aged 15 years, whose complaint on admission, on March 4, 1943, was impairment of vision of the left eye for six weeks. Two months preceding blurring of vision he had been struck in the left eye with a fist; photophobia and lacrimation followed.

The corrected vision in the left eye was 0.4. The vitreous was very hazy and contained a clot of blood. The disc margins were blurred and obscured superiorly with superficial hemorrhages over and just superior to the disc. The macular region contained a biconvex elevation, sharply demarcated and clear, through which the choroid and fovea could be seen. Striae were present in the retina on both sides of this area, having a sheen of reflexes as of traction folds. The marked engorgement of the veins had somewhat subsided. Inferior to the disc two horizontal streaks of hemorrhage were seen, apparently preretinal.

All laboratory and X-ray reports were negative; no focus of infection was found.

Persistent hyaloid-artery remnants

Dr. William Kuhlman presented

A. G., a woman aged 46 years, whose corrected vision when seen on January 6, 1943, was R.E., 1.5; L.E., 5/200, not improved with glasses. She gave a history of having had poor vision in the left eye all her life.

A persistent hyaloid remnant was seen extending from the postero-nasal surface of the lens to the nasal side of the optic disc. The fundus for a distance of 2 to 3 P.D. around the disc was obscured by large masses of black pigment which also cover the macular area. Other areas show choroidal atrophy.

Posterior vitreous detachment

Dr. William Kuhlman said that M. P., a woman, aged 38 years, had been presented before the Society one year ago. She had been under intermittent observation since December, 1939, during which time little appreciable change in the condition had been observed. Vision at this time is 1.2 in each eye.

In the fundus of the right eye, along the superior temporal vessels there is seen a delicate grayish-white semitranslucent membrane with concavity downward, projecting into the vitreous, curving downward to the nasal aspect of the disc and then along the inferior temporal vessels, where it appears to merge with the retina proper; here it does not appear to be elevated. Above, the membrane covers the vessels and a patch of old chorioretinitis as a cloud.

Scientific program

The fundus in hypertensive patients treated with sympathectomy (abstract)

Dr. Jerome A. Gans. At the University of Chicago Clinics, 18 patients of all ages and in all stages of essential hypertension were studied medically and ophthalmologically and then subjected to total (or nearly so) thoracicolumbar sympathectomy. The 15 survivals were followed for periods of from 1 to 2¼ years. In studying the material it was impossible to evaluate separately the sclerotic-vessel changes and the acute hypertensive signs, by using existing classifications. A new classification was therefore adopted which allowed separation of the sclerotic from the hypertensive signs, as follows:

Classification of Vascular Disease of the Fundus

A_0H_0—Normal

A_1—Mild arteriolar sclerosis	H_1—Arteriolar constriction
A_2—Severe arteriolar sclerosis	H_2—Hypertensive retinopathy
A_3—Same with focal insufficiency (thrombosis)	H_3—Same with papilledema

It was found that the degree of sclerosis was not affected by sympathectomy, certain patients showing a slight increase. However, the acute hypertensive signs (spasm, hemorrhage, exudate, edema of the retina, papilledema) showed a marked tendency to disappear. Those patients who had the least organic sclerosis showed the most favorable lowering of blood pressure following sympathectomy, whereas those with the most severe sclerosis were least benefited. The presence of hemorrhage, exudate, and papilledema was of less value prognostically than the degree of sclerosis of the vessels.

Discussion. Dr. Roy O. Riser felt that Dr. Gans had summarized the surgical results well; other complete reports are available in medical literature. Almost as many classifications of hypertensive retinopathy have been proposed as there are discussers of the subject, and the beginner becomes quite confused. Dr. Gans mentioned two classifications—the Keith-Wagener and the Gifford-Macpherson. The Keith-Wagener has been given more publicity in application to clinical problems, and seems to find favor with the internist. For the ophthalmolo-

gist, however, the Gifford-Macpherson has definite advantages.

Kodachrome slides taken at the University of Illinois were shown to illustrate the stages of these classifications. There is no stage in either classification for isolating cases with thrombosis of the retinal vein. One picture showed K. W., grade II in one eye and extensive hemorrhages following thrombosis in the other eye. Dr. Wagener has explained this by stating that the thrombosis was a "vascular accident" and that one should evaluate the true prognostic state by examination of the condition of the retinal vessels in the other eye. Should Dr. Gans's class A_3 really influence the prognosis as being worse than A_2?

The preoperative and postoperative fundus photographs showed the only definite findings Dr. Riser had seen in the hypertensive fundi as related to sympathectomy: first, the "flushing" of the retina following surgery in the early cases; second, the marked regression of hemorrhages, exudates, edema, and even papilledema of the late stages; and by comparison, the lack of change in the sclerotic retinal vessels, which confirms Dr. Gans's findings so definitely.

Dr. Jerome A. Gans (closing) said that it would be amiss to attempt to classify all thromboses and all vascular accidents as A_3. It should have been emphasized that this designation includes only those cases with severe vessel disease of grade A_2 having superimposed vessel thromboses. The type of vascular accident found on an embolic basis, or due to localized phlebitis, or causes other than essential hypertension, should not be included in this classification.

The present limits of gonioscopy

Dr. Peter C. Kronfeld and Dr. H. Isabelle McGarry read a paper on this subject which has appeared in this Journal (February, 1944).

Discussion. Dr. Thomas D. Allen hoped some day to get the answer to questions he had asked Dr. Wilder: Why there is less aqueous, if glaucoma is a condition of the eye in which the aqueous cannot escape? Why is the anterior chamber not deep? Why does the tension recede when a hole is made in the anterior segment?

It has been said that in deep-chamber glaucoma the condition is due to pigment which interferes with the escape of aqueous—the exit is blocked; that all that is necessary is to make a little cut in the chamber angle and the aqueous is allowed to get into the canal of Schlemm and out of the eye. Sometimes that operation will work and sometimes not. It seems to be a logical way to handle the situation, and is certainly not a difficult procedure provided the operator has first studied the angle with the gonioscope.

Those at the Infirmary are to be congratulated on their opportunity to discuss problems with Dr. Kronfeld. The work being done is in a fair way to solving the problem of glaucoma. As Dr. Kronfeld says, one must not be too dogmatic about these cases, but if contact glasses of different sizes are available, investigation of the iris angle can be made easily. In one recent case, the history was typical. The palpebral fissure was too narrow for a contact glass, so the fornix was filled with salt solution and the chamber angle could then be seen satisfactorily.

One of Dr. Kronfeld's cases recalled a similar case seen in Seidel's clinic in Vienna; narrow-chamber glaucoma with a tension of 25 mm. Hg (Schiötz). The patient was put in the dark room for two hours, but through oversight was not seen for nearly four hours, at which time the tension was around 60 mm. and the pupil was dilated. Without using a miotic, she was left in a bright light and the tension came down to 35 mm. This shows that darkness is part of the problem.

Study of these cases will help considerably; in operative cases that are successful we should try to learn why we succeeded; or if we are not successful we may learn what error was made.

Dr. Peter C. Kronfeld (closing) said that the relationship between the amount of aqueous present in the anterior chamber on the one hand, and the intraocular pressure on the other hand, becomes clearer if one tries to distinguish between preëxistent and existent conditions. If one finds, in an eye with narrow-angle glaucoma, a shallow anterior chamber in the presence of a tonometric reading of 70 mm., one should ask himself: "Was the shallowness of the chamber brought on by the rise of tension or was it a preexistent condition?" It is almost certain that in most of these cases the shallowness of the chamber was present before the pressure rose to 70 mm. It is usually the condition of the other eye that shows this very clearly; namely, the presence of a shallow chamber with narrow entrance to the angle, in the presence of a normal intraocular pressure.

There is, however, the possibility that the chamber depth may be altered by a rise in pressure. This, for instance, occurs during the hypertensive phase following anterior-chamber puncture in wide-angle glaucoma; the chamber, after having attained its original depth, becomes slightly shallow together with the rise of pressure beyond the original level. By goniometry one can occasionally observe a deepening of the anterior chamber associated with the surgical reduction in intraocular pressure. In an eye with wide-angle glaucoma the entire trabeculum but not the ciliary body may be visible before operation when the pressure is above 40 mm. After reduction of the pressure to normal by trephining or iridencleisis, in addition to the trabeculum a certain portion of the anterior surface of the ciliary body may become visible. The simplest explanation for these variations in chamber depth associated with changes in intraocular pressure is probably this: In order to maintain circulation at a pressure level of 40 mm. the entire intraocular-pressure level in the circulatory system has to be raised 15 or 20 mm. Such a rise in circulatory-pressure level is probably associated with increased blood volume in the entire uvea, which manifests itself as slight shallowing of the anterior chamber.

ROBERT VON DER HEYDT.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

March 8, 1943

DR. J. B. BLUE, *presiding*

VISUAL IMPROVEMENT IN AMBLYOPIA

DR. E. C. ELLETT reported several cases concerning the restoration of vision in amblyopic eyes in adults as the result of enforced use of the defective eye.

The first patient, W. C., aged 41 years, had a convergent squint and amblyopia of the right eye. The vision of the right eye was 4/200. The refractive error was +7.00D. sph. He had been struck in the left eye by a baseball and suffered a rupture of the sclera, with subconjunctival dislocation of the lens. He was under observation for several years and in spite of being compelled to depend on the right eye for several months completely, the vision did not improve.

The second patient, Miss B. M., an elderly woman with an amblyopic and squinting right eye, developed a cataract in her good eye. Despite the enforced use of the poor eye for many months, the vision did not improve. Removal of the cataract from the other eye restored useful vision. Her case was unusual in that she saw far and near with the same

glass. On account of the previous hyperopia, she required +16.00D. sph. for distance, and with this she saw 20/25 and J1. The squint had undergone a spontaneous cure. The right eye was normal except for a refractive error of +5.00D. sph., and the amblyopia. The vision of the right eye was 3/200.

The third patient was Mrs. S., who had been a patient for more than 40 years. Her first complaint was of poor vision. The vision of the left eye was normal with glasses; of the right eye, 20/40. In 1934 she began to develop a cataract in the right eye. The vision remained normal in the left eye but showed very faint lens changes. In 1939, macular degeneration developed in the left eye and the vision could not be improved beyond 6/60. The cataract was removed from the right eye in April, 1939. The vision in this eye was best off-center for a while, and on May 18th vision was 6/9 with glasses. In June, 1941, the left eye developed acute glaucoma, which was thought to be due to the cataract, which had matured. The latter was extracted in June, 1941. The last test in January, 1942, showed that the vision, R.E., was 6/6 and J1 with glasses, L.E. 6/60, eccentric.

The fourth patient was A. K., a man aged 30 years, who was seen in 1928. The vision was R.E., 20/200; L.E., 20/25. The vision of the right eye had always been defective and, with a normal eyeground, it was considered an amblyopic eye. Beginning in 1931 he had had several attacks of inflammation in the left eye. He was seen again in 1933, and the vision was 6/60 in the left eye due to an attack of choroiditis in the region of the macula. The vision improved in the right amblyopic eye and in January, 1934, it was 6/6 and J1. The left eye recovered after a few months. When last tested in July, 1942, the vision had receded in the right eye to 6/12 and had improved in the left eye to 6/6. The vision in the right eye remained normal for about four years, but the patient had much trouble with binocular vision and gradually suppressed the image of the right eye, as he was more comfortable when not fusing. The vision in this eye continued to decrease.

Convergence spasm under homatropine

Dr. E. C. Ellett reported a case in which a convergent squint appeared when the accommodation was suspended.

The patient was a girl, aged 6½ years, who had an alternating convergent squint for which a double recession had been done in 1935. The result was very good cosmetically, but she had diplopia with a red glass before one eye and about 10 degrees of esophoria. When she was 12 years old she was refracted under homatropine. While the homatropine was in her eyes, the right eye turned in 15 degrees, but was straight when the homatropine passed off. It was thought that the effort to see in spite of the cycloplegia caused an effort of convergence to correspond to the attempted effort of accommodation, and the excess of convergence was all spent in one eye, which squinted. Another explanation was that due to the blurring of vision caused by the cycloplegia, the stimulus to maintain binocular single vision was not present, and the eye turned in, just as an amblyopic eye was prone to do.

Chronic glaucoma followed for many years

Dr. E. C. Ellett reported two cases in which vision was preserved and tension lowered for 17 and 19 years, respectively, after a trephining operation.

The first case was that of Mrs. B. C., aged 55 years, who was seen in 1926, because of chronic glaucoma in the right eye. The history was indefinite, but she had been told about six weeks previously that the eye was hard, and she had been

given drops to use. The vision, R.E., was 6/7.5, the pupil measured 5 mm. and was fixed, the disc was white and slightly cupped, and the tensión was 60 mm. Hg (Schiötz). The patient's mentality was such that a satisfactory field of vision could not be taken. The left eye was normal, the tension 25 mm. Hg (Schiötz). A corneoscleral trephining with complete iridectomy was performed on the right eye on May 4, 1926. The eye healed normally, and in 1934 after several attempts, a visual field was taken which showed marked contraction. She was last seen in March, 1943, 17 years after the operation. The eye was white, there was a good bleb, an even coloboma with free pillars, and slight lens changes. The vision was 6/7.5 and the tension was 22 mm. Hg (Schiötz). The nerve head was still white but only slightly depressed, more like an atrophic than a glaucomatous cup. The left eye was normal.

The second case was observed in a woman who had been under observation since 1919. She gave a history of poor vision in the left eye for the preceding 15 years. The eye was practically blind, the tension was high, and the disc was cupped. A trephining operation was performed to relieve the pain and it succeeded in doing that, although the vision was not improved. The disc of the right eye was definitely cupped, but the tension was not high and the vision was normal. The highest tension recorded was 28 mm. Hg (Schiötz). A trephining with a peripheral iridectomy was done on this eye in January, 1924. In July, 1942, the vision was 6/6 and J1, and the tension was 18 mm. There was a defect in the upper nasal quadrant of the visual field, but this had not changed for many years.

Tendon transplantation for paralytic esotropia

Dr. Phil Lewis presented a 65-year-old colored man who had been recently operated upon for an old paralytic strabismus.

In 1907, 36 years previously, this man had developed a sixth-nerve paralysis which caused a marked internal squint. As time went on the squint became worse, so that for the past 15 or 20 years only the temporal border of the cornea could be seen. The amount of esotropia measured about 90 degrees. Attempts to rotate the eye outward with forceps and strabismus hook proved impossible due to the contracture of the internal rectus.

About two weeks previously operation was performed under cocaine and novocaine anesthesia. Turning the eye out sufficiently to reach the internal-rectus muscle was very difficult, but was finally accomplished. The muscle was very fibrous and seemed to have lost almost all its elasticity. It was recessed almost 7 mm. Transplantation was done on the lateral halves of the inferior and superior recti to beneath the stump of the externus, which was resected 15 mm.

A kodachrome photograph was presented to show the appearance before operation. For the first week the eye was overcorrected. The cornea showed some diffuse opacities but some vision remained, about 5/200, after over 30 years of nonuse. The eye was becoming slightly crossed again and there was no outward motion.

This patient was presented to show what might be accomplished in even very severe chronic cases of paralytic strabismus. It is obviously much better to operate before contractures occur.

Bilateral monocular diplopia with amblyopia

Dr. Phil Lewis presented a woman, aged 49 years, who was first seen in November, 1942, complaining of poor vision and diplopia. She stated that about 14

years previously she had completely lost her vision, supposedly due to "cotton blindness." This lasted several weeks, but her vision never seemed to recover fully. For the past five or six years double vision had been constant with either eye or both. Headache was frequent, but she had suffered no serious illness in her entire life. She had taken quinine several times but never very much at any one period.

Examination showed that both eyes were normal externally. The media were clear, and the fundus was normal in each eye. Vision could be improved to only 20/100 in the right eye, and 20/200 in the left eye, with +1.00D. sph. before each eye. With the addition of +2.25D. sph. she could read J10. With each eye separately she saw a blurred false image close by the true image of whatever she was looking at. With both eyes open the two clearer images fused and the two blurred images fused so that she still had diplopia rather than polyopia. This was found true in the six cardinal directions of gaze with a red glass and a small light. There was orthophoria for both distance and near. The curvature of the cornea was normal in each eye with the Javal ophthalmometer. Slitlamp study of the cornea and lens in each eye was negative. The visual-field studies were normal. The blind spot of the right eye was practically normal, but that of the left eye was considerably enlarged. The patient's blood and general examination were normal except that she was underweight. She had improved in general health in the past four months by a better diet, yeast, and vitamin capsules. Her eyes remained the same.

This patient was presented with the hope of arriving at an explanation of the condition and possibly some remedy for it.

SAINT LOUIS OPHTHALMIC SOCIETY

March 26, 1943

DR. CARL BEISBARTH, *president*

DIAGNOSIS OF MALIGNANT MELANOMA BY BIOPSY

DR. B. Y. ALVIS gave the clinical aspects of a case of an apparently normal serous type of retinal detachment. At the time of the operation a sclerotomy was done, but no subretinal fluid was found. The Graefe knife, used to make the sclerotomy incision, encountered a semisolid, gelatinous tissue after penetrating the sclera. By inserting a small curette through the opening Dr. Alvis secured a small amount of this gelatinous material which was then smeared on a slide and sent to the laboratory for examination by Dr. T. E. Sanders. With hematoxylin-and-eosin staining the smear showed cells resembling type B spindle cells. From these findings a diagnosis of intraocular tumor was tentatively made, and the eye was enucleated. Microscopic examination of the removed eye revealed a mixed-cell type of malignant melanoma. It was, therefore, recommended that all retinal detachments should have a transcleral type of transillumination to reveal a tumor, if present.

Discussion. Dr. Carl Beisbarth asked what the tension was in this case.

Dr. Alvis replied that it was normal.

Dr. Beisbarth then stated that three or four years ago he had had a patient with a small tumor easily observable near the macula. In this case the tension was always a little higher in the eye with the tumor than in the other eye. After enucleation the pathologic diagnosis turned out to be that of malignant melanoma. He then asked Dr. Sanders if there was any evidence that puncturing a tumor, as in the reported case, could cause it to spread locally and wondered of how much

value transillumination was.

Dr. Sanders said that there was a definite chance of the tumor cells being spread through the sclerotomy opening. When this procedure is done it should be done in the operating room so that if necessary the eye can be removed promptly.

Dr. J. H. Bryan asked if the thermophore might not be used on such choroidal tumors and asked Dr. Shahan if he had not tried it.

Dr. Shahan replied that he had used the thermophore on one case of tumor of the iris which had spread posteriorly. A biopsy was taken and a diagnosis of malignant melanoma made and then the thermophore was applied so as to cover the entire area involved. The eye was still functioning after several years, without any sign of recurrence.

Dr. Sanders added that he had seen Dr. Shahan's case and had been unable to find any evidence of tumor. He said that a tumor of the iris is quite different from a choroidal tumor. They seem to behave quite differently. The death rate from a tumor of the iris is much less than that from a choroidal tumor and it is not fair to compair the prognosis of one with that of the other. He then discussed the question of metastasis, stating that the longer the tumor is in an eye the greater the chance that some of the tumor cells will spread. Metastasis is certain to occur at some time. The earlier an enucleation is done the less time there is for metastasis to occur. That is true in general of all the tumors although some types tend to metastasize much earlier than others.

Massive bilateral preretinal type of hemorrhage associated with subarachnoidal hemorrhage of the brain with a case report and pathologic findings

Dr. L. C. Drews and Dr. Jeff Minckler presented a paper on this subject which was published in this Journal (January, 1944).

Choroideremia

Dr. R. G. Scobee presented a paper on this subject which was published in this Journal (November, 1943).

Discussion. Dr. L. C. Drews said that in Hess's article on retinitis pigmentosa in Kurzes Handbuch der Ophthalmogie, he makes a definite statement that choroidal disease had nothing to do with retinitis pigmentosa. In spite of that the disease picture has been produced experimentally by cutting the long posterior ciliary nerves. Dr. Drews said that he had been interested in the treatment of retinitis pigmentosa with retinal choroidal pigment. Considerable clinical work has been done on this, with variable results. A rather interesting point was that several authors had reported isolated cases of choroideremia occurring in the same families that had retinitis pigmentosa in other members of the family. Returning to the subject of treatment of retinitis pigmentosa he said that Dr. Luedde had been using retinal choroidal pigment for over 20 years and that apparently in early cases sometimes favorable results were secured. Dr. Drews had seen cases where marked improvement in the visual fields occurred during the course of injections of the retinal choroidal pigment but that these same patients, when treated for six months with injections of different solutions such as saline, typhoid vaccine, milk, and tuberculin, showed no change in the visual fields. He asked Dr. Scobee if there were many cases of well-advanced choroideremia without posterior cataract.

Dr. Scobee said that choroideremia has been considered possibly a primary degeneration of the choroid. In retinitis pigmentosa there is a proliferation of tissue over the surface of the retina. In choroideremia the retina becomes atrophic. As far as the incidence of cataract is concerned in the 36 patients reported only one had a cataract.

James Bryan,
Editor.

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Author's proofs should be corrected and returned within forty-eight hours to the *Manuscript Editor, Miss Emma S. Buss, 5428 Delmar Boulevard, Saint Louis 12, Missouri.* Twenty-five reprints of each article will be supplied to the author without charge. Additional reprints may be obtained from the printer, the George Banta Publishing Company, 450-458 Ahnaip Street, Menasha, Wisconsin, if ordered at the time proofs are returned. But reprints to contain colored plates must be ordered when the article is accepted.

CYCLOPLEGICS

The use of cycloplegia for diagnosis of refractive errors is almost universal among physicians who undertake this kind of work. That is to say, nearly all of them use cycloplegia in a goodly proportion of their patients. Some restrict the use of diagnostic cycloplegia to children and young people, up to the age of thirty years. Many make it a rule never to use cycloplegia for this purpose beyond the age of forty or forty-five years, excluding its use in later life for fear of producing glaucoma, although in dealing with anterior uveal inflammations (as distinct from the "inflammation" of congestive glaucoma) every ophthalmologist would use cycloplegia at any age. It has not been altogether satisfactorily demonstrated that medicinal cycloplegia tends to produce glaucoma in an eye that does not already have the disease, at least in a prodromal stage, but it is a wise precaution to test the tension of middle-aged and senile eyes in which cycloplegia is to be or has been used diagnostically.

The extent to which different ophthalmologists rely upon the refractive meas-

urements obtained under cycloplegia varies greatly. A few never or hardly ever employ cycloplegia in refraction work, regarding it as unnecessary and even misleading. The majority, however, consider it as indispensable, although, strangely enough, many of them measure the refraction under cycloplegia and then throw away much of the advantage thus derived in that they depend largely, for the final prescription, upon a hastily performed postcycloplegic measurement.

Whether therapeutically or as a diagnostic aid in refraction, virtually only three cycloplegics (as contrasted with mydriatics) are available; namely, atropine, hyoscine (also known as hyoscyamine or scopolamine), and homatropine. Therapeutically, atropine is most frequently employed, because with powerful and lasting cycloplegic action it combines a relative freedom from toxic effects. Yet it must sometimes be replaced therapeutically by hyoscine, which is less apt to cause severe and disturbing irritations of skin and conjunctiva. Hyoscine, actually more powerful than atropine in proportion to the concentration of the solution used for instillation, is unfortunately capable of producing in many individuals important nervous reactions, particularly motor incoördination.

The therapeutic effect of homatropine is relatively insignificant, although its frequent instillation in disturbances likely to be of short duration is occasionally helpful, and has the particular advantage of an action which is brief and easily arrested. In the occasional case in which it is proposed to change over from miotics to cycloplegics, the reversal of therapeutic procedure may well be started by keeping the patient in the doctor's office and watching the effect of several instillations of a solution of homatropine. If these act favorably as to pain and do not raise the intraocular pressure, it is usually safe to change over to a solution of hyoscine or atropine.

The cycloplegic most widely used in refraction work, on the other hand, is homatropine, because with satisfactory brevity it combines a highly useful, although frequently somewhat incomplete, degree of cycloplegia. It is slightly toxic in some patients, although, as the present writer has shown (American Journal of Ophthalmology, 1926, volume 9, page 270), this toxicity is practically negligible if the drug is always instilled shortly after a fairly substantial meal. (Where only a single drop of a strong solution of homatropine is used in each eye, a similar protection may be afforded by having the patient take milk and some solid food immediately after this drop is instilled.)

The incompleteness of homatropine cycloplegia is not infrequently a real inconvenience. Oddly enough, more reliable results are occasionally obtained several hours after the use of the drug, and at a time when the cycloplegia is noticeably diminishing, than during the test made when cycloplegia should theoretically be most efficient. The refractive measurement under homatropine is at times so tantalizingly variable and indefinite that it is well to resort to one of the more powerful drugs, hyoscine and atropine, although here, of course, the inconvenience these drugs would cause the patient is a more or less serious obstacle.

It cannot be too often emphasized that the finality of the test under homatropine is greatly enhanced by remembering the possibility of incomplete cycloplegia and applying the unilateral or bilateral maneuvers of the fogging method during the cycloplegic test. Disregard of this practical rule vitiates many cycloplegic and postcycloplegic tests made in connection with the use of homatropine, or even, now and then, of one of the stronger drugs.

Calculations as to the exact interval within which the refraction should be measured after homatropine instillation look well on paper, but must often be imperfectly followed during crowded office or clinic practice. To remedy, in troublesome cases, the incompleteness and fleeting character of homatropine cycloplegia, hyoscine offers a tempting compromise between the inadequacy of the weaker synthetic and the very prolonged action of atropine.

Subject to the rule about a fairly full stomach, most adult patients are sufficiently tolerant to the use in each eye of a single drop of hyoscine hydrobromide, one grain to the ounce. A few are distressingly dizzy after this amount of the drug, although usually they are able to proceed with the test and can go home unaided. A full hour of waiting after the instillation is advisable, and the precision of the cycloplegia obtained is generally excellent.

Because any one of the cycloplegics presents frequent disadvantages, it is natural that attempts should be made to find new cycloplegics or new cycloplegic combinations which give promise of relief from these inconveniences. For the sake of the patient, we should all like to find a drug which would combine the brevity of action of homatropine with the more complete cycloplegia of hyoscine or atropine and which would lack toxic effects.

In view of the many triumphs of pharmacologic research, it seems not impossible that some day such a cycloplegic combination will be found, although we are likely to remember that no feat of research has produced a drug which did not prove toxic to a minority of those to whom it was administered.

We have to remember, also, that the briefer the action of a cycloplegic drug the greater the precision required as to timing of the examinations made under its use, and the greater the possibility that it will not always suit the exigencies of daily practice. It is perhaps too much to hope that a powerful and rapidly acting drug would be equally effective in all patients, or that it would be uniformly free from allergic reactions or tendency to disturb the corneal surface.

A brilliant illustration of the problems to be solved and the difficulties likely to be encountered is to be found in the recent reports of Swan and White on their experiments with di-n-butylcarbaminoylcholine sulphate (Archives of Ophthalmology, 1944, volume 31, April, page 289, and elsewhere*). The desiderata satisfied by this drug are said to be ready availability, inexpensiveness, chemical stability, bactericidal quality, and absorbability, as well as freedom from toxic reactions, from a tendency toward irritation, from vasodilatation, from production of anesthesia, and from increase in intraocular pressure.

The new drug, like homatropine, has a bitter taste. To remain stable for weeks at room temperature, it must be kept in a dark glass bottle. Heat and light result in slow decomposition, which can, however, be detected with litmus paper. Partially decomposed solutions become slightly irritating. The new drug lacks the "considerable chemical incompatibilities of the tropine alkaloids."

The effectiveness of a 7.5-percent solution is apparently about equal to that of a 5-percent solution of homatropine hydrobromide. In the 7.5-percent strength it was found to produce mydriasis and cycloplegia beginning in from twenty to thirty minutes and becoming maximal in fifty to seventy minutes. Its effect differs from that of the tropine derivatives in that its mydriasis and cycloplegia develop and wear off concurrently. Maximal ef-

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* Editor's note: See p. 933 of this issue.

fect continues for two to three hours, and the effect of a single instillation passes off completely within from seven to twelve hours. After two instillations ten or fifteen minutes apart, the effect continues several hours longer.

The amount of plus sphere accepted under the new drug averaged very slightly (0.04D.) less with the new drug than with homatropine, and only insignificant differences were found in the astigmatic measurement.

No doubt the new drug will be subjected to clinical tests at the hands of many ophthalmologists. It will be interesting to learn what seems to be the general conclusion as to substantial advantages or disadvantages of the drug as compared with homatropine. It is not likely that finality has been reached in the search for an ideal cycloplegic. Perhaps we may still hope that pharmacologic experiments will some day usher in the use of a new hyoscine or atropine derivative which will be powerful, brief in action, and free from objectionable toxic effects.

W. H. Crisp.

EYE EXAMINATION IN SCHOOL CHILDREN

One of the most important contributions to eye welfare has been the establishment of ocular examinations in our schools. This has become almost universal in public schools and is the general practice in private schools. An important question is what should be the nature of these tests.

Factors pertaining to sight that must be considered are external diseases, central visual acuity, muscle balance and power, fields of vision, fundoscopy, color discrimination, fusion, and refraction. The first two mentioned are obviously necessary if the tests are to have any value.

The central acuity of each eye at 20 feet in children is usually considered to be a good measure of the acuity at the reading distance except in the case of myopia, in which condition the test at 20 feet is probably justly regarded as the crucial one in uncovering the near sightedness, so that it is thought unnecessary to try the vision at 14 inches, and the customary visual tests in schools is only that at 20 feet.

Dr. Myrtle Mann Gillett reports in this issue on seeing defects in 2,500 nonreading children from a 20 years' study. Among other interesting findings is that approximately 25 percent of a group of 1,587 children who presumably had normal vision at 20 feet could not read ordinary type at 14 inches or less. Of these 286 could read such type at three or more feet. These reports, if confirmed, would indicate that tests at the usual reading distance should be carried out as a part of the routine visual tests of school children as well as those at 20 feet.

Another interesting point was that in about 25 percent of these children—though presumably not in just the same subjects as those previously described—no convergence could be elicited, and only a few of these children were strabismic. This constitutes an excellent argument for tests of dynamic and static muscle-balance measurements.

In order to be able to state with assurance that the child does or does not need eye care, a much more extensive examination than that usually given is necessary; really a complete eye test. Whether this should be provided by the school is another problem and not to be discussed here.

That there is often an undeveloped physio-psychologic element in nonreaders is also a well-known fact. Ophthalmologists continually examine children who are sent to them as nonreaders, most of whom have only minor refractive errors

and are surmized to lack the needed coördination of eyes and higher centers; but perhaps not sufficiently exhaustive tests have been made. There are probably not many ophthalmologists who trouble themselves to make the tests necessary to determine lack of higher coördination even if they have been trained to do so. In few small cities and not even in all large ones are there facilities for a thorough study of these patients and for giving the appropriate training that is indicated.

We can only conclude that more complete eye tests should be made both in schools and in the offices of ophthalmologists when children with reading difficulties are referred to them. If possible someone trained in psychiatry who has studied remedial reading should be the director of an organization of technicians sufficient to serve the community, to whom could be referred the cases of this character. In many cities orthoptic laboratories are handling the phase of muscle-training adequately for ophthalmologists, but the problem of remedial reading has scarcely been considered.

Lawrence T. Post.

BOOK NOTICES

THE PRINCIPLES AND PRACTICE OF OPHTHALMIC SURGERY. By Edmund B. Spaeth, M.D. Third edition, thoroughly revised. Clothbound, 934 pages, 556 engravings, containing 798 figures and 6 colored plates. Philadelphia, Lea & Febiger, 1944. Price $11.00.

One of the books that is most frequently withdrawn from the library of the Department of Ophthalmology in Washington University is this book on ophthalmic surgery. The third edition is even better than the previous two in that the size has been reduced, but the material increased. It is surprising how much material has been included in this book and how exact it is. Any who neglected to buy either of the first two editions should certainly not fail to own the third.

Almost every outstanding ophthalmic surgeon's contributions to our specialty are included. Illustrations are especially noteworthy and definitely accomplish their purpose of instruction.

Lawrence T. Post, M.D.

TRANSACTIONS OF THE AMERICAN OPHTHALMOLOGICAL SOCIETY, volume 41, 1943. Clothbound, 628 pages. Printed by Wm. F. Fell Co., Philadelphia, Pennsylvania.

The seventy-ninth annual meeting of the American Ophthalmological Society was held at Hot Springs, Virginia, on June 10, 11, and 12, 1943. Dr. Hunter McGuire presided. In this publication are 32 papers, including 9 theses. Twenty of the articles deal primarily with ocular pathology, four with surgical procedures, and three with therapeutic measures. Eighteen of the essays have been published or accepted for publication in the American Journal of Ophthalmology and are not included in this review.

The diagnosis, classification, and therapy of keratoconjunctivitis sicca are discussed by the late Sanford Gifford, Irving Puntenney, and John Bellows. The use of gelatin in Locke's solution in mild cases with closure of the canaliculi also in more severe cases has given satisfactory results.

The distribution of certain oxidative enzymes in the ciliary body has been investigated by Jonas S. Friedenwald, Heinz Herrmann, and Robert Moses. Original methods of isolating the secretory portion of the ciliary body were described.

The visual-field studies, following surgical division at the chiasm of the crossed macular fibers, were made by John N. Evans and Jefferson Browder. The visual acuity resulting from division of the crossed macular fibers was approximately 20/40. The authors conclude the entire macula may be supplied by both crossed and uncrossed fibres.

The relationship between retinal detachment and trauma has been investigated in 400 successive cases by Arnold Knapp. Myopia was encountered in 50 percent; trauma, direct or indirect, in 12 percent; aphakia in 9 percent. The detachments were bilateral in 14 percent. The role of indirect trauma (strain, lifting, coughing), in producing a detachment, is obscure.

Histologic sections of a case of primary retinal tuberculosis and one of Boeck's sarcoid of the retina were presented by Alexander E. MacDonald.

The treatment of corneal opacities by keratectomy was described by Ramón Castroviejo. Excellent photographs of the various surgical procedures were presented. Use of opaque corneal tissue to enlarge the cul-de-sac was recommended.

A study of the lenses in 20 globes that had suffered from nontraumatic iritis was made by Bernard Samuels. Folds in the lens capsule, changes in the epithelium, death of the subcapsular epithelium, and changes in the substance of the lens were noted.

A discussion of a case of recurring attacks of concomitant exotropia, each followed by transient esotropia, was presented by F. H. Verhoeff. A vasomotor disturbance of the nuclei of the interni or in the convergence center was thought to be associated with migraine.

Raymond L. Pfeiffer studied 120 cases of fracture of the bones of the face in which the orbit was involved, and in 53 enophthalmos developed. The usual fracture was in the orbital floor, with displacement of the orbital contents into the maxillary sinus. Roentgenography was required for diagnosis. Methods of treatment were described.

A case of tuberous sclerosis was recorded by Ernest F. Krug and Francis A. Echlin.

A new treatment of foreign bodies of the cornea was described by D. F. Gillette. The area of the foreign body is touched lightly with silver nitrate, 1 percent; this causes swelling and softening of the superficial tissue. After one minute the foreign body may be removed with a softened wooden toothpick or cotton-wound applicator. With the aid of pigment staining of the cornea the ring is readily removed with the point of a cystotome.

A review by Frank N. Knapp of the literature on the treatment of ocular tuberculosis reveals the difficulty of establishing the diagnosis and the multiple methods of treatment recommended. The ideal treatment should include the routine followed in the sanatorium for tuberculous patients. The use of tuberculin, radium, X-ray, gold, hemotherapy, typhoid-H antigen, and typhoid vaccine are considered in this article.

Lipaemia retinalis occurs in the nondiabetic when the blood-fats rise above 3.5 percent and disappears when the blood-fats fall below 2.5 percent. A case in a nondiabetic was investigated and reported by Cecil W. Lepard.

The material presented in this volume, edited by Wilfred E. Fry, is free of war material, shortages, or controversy. The work advances the traditional standards of American ophthalmology.

William M. James.

CORRESPONDENCE

Lenses for avoiding diplopia

July 29, 1944

To the Editor,
American Journal of Ophthalmology:

In the discussion of spinal anesthesia followed by paresis of the external rectus muscle, Dr. L. R. Lang suggested giving the patients glasses in which the outer half of the lens in front of the involved eye is occluded, thereby eliminating diplopia in the affected field (Amer. Jour. Ophth., 1944, v. 27, p. 772).

When, in 1927, I published a paper entitled: "Partially frosted lenses and biprismatic lenses in the treatment of ocular muscular disturbances" (Klin. M. f. Augenh., v. 79, p. 211), I considered the same scheme; that is, placing a partially frosted lens before the involved eye. Later on, I improved this method, using the partially frosted lens corresponding to the *not* involved eye in cases of paresis of the external rectus muscle; the nasal half of the lens before the nonparetic eye was frosted to avoid the loss of the temporal half of the visual field of the paretic eye; thus, the patients did not notice any discomfort resulting from diplopia, and were not as much incapacitated as with a shielded temporal half of the visual field.

These partially frosted lenses were used in acute cases. When, after some months, the paresis and diplopia did not disappear entirely but the distance of the double images grew smaller, I used biprismatic lenses; that is, a lens one half of which was combined with a prism. For external rectus paresis, this prism is to be fitted with its base out, and its extent and strength should depend on the severity of the paresis. Usually, the full temporal half of the lens was covered by the prism, base out. This, of course, did not prevent diplopia in extreme lateral rotation, due to the increase of the diplopia with gaze in the direction of the action of the paretic muscle; but in mild cases, it was sufficient to prevent annoying doube images for the usually needed range of lateral rotations.

(Signed) K. W. Ascher.

Correction

July 19, 1944

To the Editor,
American Journal of Ophthalmology:

India being so far away, I have finally received a copy of my paper on Binasal hemianopsia. I wish to correct one typographical error. The patient was first admitted to Children's Hospital (Cincinnati, not Chicago). He was later observed in the Eye Department of the Cincinnati General Hospital.

(Signed) Irwin E. Gaynon,
Capt. (MC).

ABSTRACT DEPARTMENT

EDITED BY DR. WILLIAM H. CRISP

Abstracts are classified under the divisions listed below, which broadly correspond to those formerly used in the Ophthalmic Year Book. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. General methods of diagnosis
2. Therapeutics and operations
3. Physiologic optics, refraction, and color vision
4. Ocular movements
5. Conjunctiva
6. Cornea and sclera
7. Uveal tract, sympathetic disease, and aqueous humor
8. Glaucoma and ocular tension
9. Crystalline lens
10. Retina and vitreous
11. Optic nerve and toxic amblyopias
12. Visual tracts and centers
13. Eyeball and orbit
14. Eyelids and lacrimal apparatus
15. Tumors
16. Injuries
17. Systemic diseases and parasites
18. Hygiene, sociology, education, and history
19. Anatomy, embryology, and comparative ophthalmology

9

CRYSTALLINE LENS

Bellows, J., and Nelson, D. **Cataract produced by anoxia.** Arch. of Ophth., 1944, v. 31, March, pp. 250-252.

The transparency of the crystalline lens depends on proper utilization of nutrient material supplied by the aqueous. If for any reason there is a local deficiency of some vital constituent, the lens becomes opaque. The most vital requirement of tissue is an adequate supply of oxygen. The necessary rapid replenishment of oxygen in the aqueous is made possible by rapid diffusion from the ciliary body and by passage of oxygen from the atmosphere through the cornea.

The authors undertook experiments to determine whether anoxia alone would produce cataract. Rats were placed in a steel chamber in which the pressure was gradually reduced. When the conditions were severe enough to cause death of 50 percent of the animals, it was found that about 75 percent of the dead animals and 10 percent of the survivors had lens opacities. That the cataracts were influenced by anoxia was demonstrated by control experiments in which rats were placed singly in glass chambers arranged to permit the constant flow of gases at sea-level pressure. Again the rats showed lens opacities, but to a lesser degree.

Rabbits were used to determine the lactic-acid content of the aqueous, as these animals are known to be resistant to changes in altitude. The aqueous was removed from one eye of each animal under ether anesthesia. After recovery for two hours, some of the animals were put in cases as controls, and the others were placed in the decompression chamber. After two hours the pressure in the chamber was restored to the normal level, the animals were anesthetized again, and the aqueous was removed from the second eye. Whereas the average lactic-acid content of the aqueous in all the eyes first studied and in the second eyes of the control rabbits ranged from 70 to 75 mg. per hundred c.c., the average lactic-acid content of the aqueous in

the second eyes of the animals in the decompression chamber was three to four times as high.

In some sections of cataract due to anoxia, there were noted subepithelial vacuoles, clumping of nuclei, and exudate on the lens capsule. After decompression there was conspicuous hyperemia of the iris. With oblique illumination, small diffuse gray opacities were seen in the superficial part of the cortex. With the higher magnification of the slitlamp, the changes were seen to begin with opacification of the anterior sutures, from which fine fibrillar opacities extended. In optical section it was seen that the entire opacity was thin and lay in the superficial layers of the cortex. Gradually the opacity extended toward the periphery. The opacity lasted from about three quarters of an hour to one hour and then gradually retrogressed, the order of retrogression retracing exactly the course of development, so that the last opacities to disappear were those about the sutures.

Examination revealed no changes in the lenses of human volunteers placed in the decompression chamber. (References, 3 figures.)

R. W. Danielson.

Clapp, C. A. **A report on a family with ectopic lenses.** Amer. Jour. Ophth., 1944, v. 27, July, pp. 738-740. (Illustrations, references.)

Foglia, V. G., and Cramer, F. K. **Experimental production of diabetic cataract in the rat.** Proc. Soc. Exper. Biol. and Med., 1944, v. 55, March, p. 218.

Male white rats were almost completely pancreatectomized by the authors, leaving between 5 percent and 20 percent of the organ. The blood-sugar level was determined and a standard diet given. The lens lesions which occurred were classified in four degrees of increasing severity, as follows: type A, alteration of the anterior capsule of the lens (rugosity); type B, opacity of the lens sutures; type C, partial opacity of the lens parenchyma; type D, total opacity of the lens parenchyma.

All of 41 rats with only 5 percent of the pancreas developed cataracts in fifty days or more. These cataracts were progressive, and varied in severity directly with the height of the fasting blood sugar. Very few rats with a normal level of blood sugar had lesions, whereas all rats with a level greater than 220 mg. had lesions of the most serious types, C or D. The rats with 20 percent of the pancreas showed a lower incidence of diabetes and correspondingly less frequent and less severe lens lesions. These cataracts took over 200 days to appear, and were never more severe than type B. In one hundred normal rats taking the same diet no similar lesions were seen.

Robert N. Shaffer.

Friedman, B. B. **Treatment of epithelial ingrowth following cataract extraction.** Amer. Jour. Ophth., 1944, v. 27, July, p. 764.

Harned, J. W. **Pseudoaphakia fibrosa.** Arch. of Ophth., 1944, v. 31, March, p. 253.

Harned reports a case the details of which suggested that the defect was not primary aphakia, but secondary aphakia, or pseudoaphakia, from degenerative changes occurring in the lens during the fifth week of embryonic life, as described by Mann.

R. W. Danielson.

10
RETINA AND VITREOUS

Figueiredo, N. P. de. **A case of persistent hyaloid artery.** Rev. Brasileira de Oft., 1944, v. 2, March, pp. 121-123.

The patient, a white man of 26 years, had a left eye which deviated slightly upward and inward, had never seen well, and the visual acuity of which was limited to one tenth. There was a small white opacity at the posterior capsule of the lens, and from this position a fluffy fine thread extended far backward into the vitreous. With movements of the eyeball, the thread moved freely in all directions. This structure was interpreted as representing persistence of the obliterated hyaloid artery. The author reviews ten references from the literature.

W. H. Crisp.

Gifford, S. R. **An evaluation of ocular angiospasm.** Trans. Amer. Acad. Ophth. and Otolaryng., 1943, 47th mtg., Sept.-Oct., pp. 19-30.

Methods of studying peripheral circulation are reviewed. Three fairly well-defined types of ocular pathology are described in which peripheral angiospasm seems to be a causative factor. The first is a central angiospastic retinopathy, the typical picture of which is sudden reduction of central vision in one or both eyes with edema of the macular area. The average age of patients was 36 years. Nearly all smoked. Normal vision, or nearly normal vision, was restored in two to six weeks of antispasmodic treatment, which is described in detail.

The second type is periphlebitis retinae with recurring vitreous hemorrhages in young adults. Although in the majority of these tuberculosis is of causative importance, in a small group peripheral vascular disease seems to be of primary importance. These may well be given the benefit of treatment to improve the peripheral circulation.

For the fourth type a case is presented of extreme attenuation of the retinal arterioles in a postoperative cataract patient who showed marked peripheral angiospasm and improved on antispasmodic treatment. It is suggested that in these three syndromes an examination of the peripheral vascular system is indicated. Such an examination is advised also in other conditions in which vasodilators are to be used. (One table, 2 illustrations, references.)

Katharine H. Chapman.

Landau, A., and Ruszkowski, J. **A case of exudative and hemorrhagic retinitis, with increased intraocular tension, treated by pilocarpine and thyroid.** Brit. Jour. Ophth., 1944, v. 28, April, pp. 184-187.

The patient was a woman forty years of age who reported for examination because of a blind painful right eye. She gave a history of injury above her right eye in a motor accident in 1937. A week after the accident she noticed a dark spot in front of the right eye. A patchy retinal hemorrhage was found by an ophthalmologist. Following the accident, her vision became steadily worse. Two months after the accident, another oculist found the tension increased and performed an antiglaucomatous operation. The sight continued to fail and in 1939 the eye became totally blind and painful. On examination the tension was found to be 90 mm. Hg (Schiötz). The cornea was cloudy and the anterior chamber was half filled with blood. The fundus could not be seen. The left eye showed

no pathologic changes, the tension was normal, the vision 6/5. The right eye was enucleated.

Five months later the patient reentered the hospital with a history of a dark spot appearing before the left eye, a week after dental extractions. Examination of the eyeground revealed numerous hemorrhages and exudates near the optic disc. The vision was decreased to 6/18. The patient was readmitted to the hospital. During the first month the vision continued to decrease and eventually there was an attack of glaucoma with high tension. The attack was relieved by pilocarpine but the vision has decreased to counting fingers at 18 inches. In order to keep the tension down it was necessary to instill 2-percent pilocarpine three or four times daily.

It was clear that the morbid process in the left eye was a repetition of that in the right eye. The fundus picture was similar to that of severe hypertensive retinopathy. Taking into consideration the fact that the retinal changes in hypertension are caused by diseased arterioles and since the patient's blood pressure was normal (120/90), the author was forced to conclude that this was a case of arteriolitis of unknown origin. Foreign-protein shock-therapy was started, injections of sterilized milk being given every second or third day. After the third injection (15 c.c.) the patient had a high fever and a glaucomatous reaction, which was attributed to spasm of the arterioles. Persistent instillation of pilocarpine stopped the attack of glaucoma.

French publications (Chaufford, 1920) have shown that exudative patches of retinitis contain many lipoids and that such retinopathy is associated with hypercholesterolemia. The blood cholesterol of this patient was 180 mg. percent and her basal metabolic rate was minus 10 percent.

Thyroid tablets one grain thrice daily were given from July 29 to October 10, 1942. From the beginning of this treatment, the vision started to improve. There were no more attacks of glaucoma. To avoid the tachycardia and other general actions of the thyroid, half a grain of phenobarbitone was used twice daily. From October 10, 1942, until January 16, 1943, the thyroid was discontinued. During this period the patient was given injections of acetylcholine, and for many weeks afterward she was given nicotinic acid because of its vasodilator action. Since January 16, 1943, she has been taking thyroid again, one grain every second day with phenobarbitone half a grain twice daily. Vision has increased to 6/18. Pilocarpine once daily controls the tension.

The author assumes that the thyroid treatment prevented glaucoma from taking a hemorrhagic, malignant course, and he recommends that cases of retinopathy of unknown origin be treated by vasodilator methods.

Edna M. Reynolds.

Lijó Pavía, J., and Cerboni, F. C. **Concerning double retinal pulsation and its cinematographic record.** Arch. de Oft. de Buenos Aires, 1942, v. 17, Aug., p. 485.

The authors studied by means of retinocinematography the so-called double retinal pulsation produced by application of the pressure of the ophthalmodynamometer, which elicits a venous pulsation at the same moment that the arterial pulsation appears. Bailliart considered this to be due to an obstacle in the return venous

circulation, and the authors present a case in support of this opinion. A 53-year-old man with systemic hypertension showed numerous retinal hemorrhages and edema in the fundus of the right eye, due to obstruction of the central retinal vein. When a tonoscopic examination was carried out, the double retinal pulse was observed and recorded on a cinematographic film at a speed of 24 frames per second. A more detailed study was made possible by increasing the speed to 62 frames per second, which made the projection time of the interval between pulsations slightly longer than one second.

Plinio Montalván.

Remonda, Juan. **Congenital fold of the retina.** Arch. de Oft. de Buenos Aires, 1942, v. 17, Sept., p. 586.

A case of congenital fold of the left retina is presented. The literature is discussed in detail. (Illustrations.)

Plinio Montalván.

Veirs, E. R. **Retinal detachment seen in an Army general hospital.** Southern Med. Jour., 1944, v. 37, April, pp. 224-226.

The 21 cases reported represented 4.9 percent of the total admissions, the average age being 27.8 years. All were unilateral and 11 were surgically treated. Only 23.8 percent were myopic and about 20 percent were of traumatic origin. More than one-half had tears or holes. Diathermy was used in all the surgically treated. Machines especially constructed for detachment work are not considered essential. Retrobulbar injection of 2-percent procaine with topical applications of 2-percent butyn were used. A flattened retina immediately after operation is considered a good prognostic omen, and associated local evidence of infectious disease suggests a worse prognosis.

Charles A. Bahn.

Vidal, F., and Malbran, J. L. **The path of the inferior peripheral homolateral fibers in the cat. Retinal microlesion.** Arch. de Oft. de Buenos Aires, 1942, v. 17, Sept., p. 521. (See Section 19, Anatomy, embryology, and comparative ophthalmology.)

Wyburn-Mason, R. **Arteriovenous aneurysm of mid-brain and retina, facial nevi, and mental changes.** Brain, 1943, v. 66, Sept., pp. 163-203.

An attempt is made to define the condition in which an arteriovenous aneurysm of the mid-brain is associated with congenital anomalies of the retinal vessels, with often a tract of vascular tissue connecting the two lesions, a vascular nevus in the neighborhood of the affected eye, and perhaps mental symptoms. Figures showing the peculiar appearance of the ocular fundus are reproduced from the articles of various authors. One plate shows a coronal section of the upper part of the pons, mid-brain, and the region of the third ventricle, with an arterovenous aneurysm of the dorsum of the mid-brain invading the right side; and a transverse section of the pons and the upper part of the cerebellum, showing extension of the aneurysm into the upper part of the ventricle, together with a drawing of the corresponding fundus. An embryologic explanation of the condition is offered, and the differential diagnosis is discussed. Several cases which appear in the literature are summarized, with comments on the pathology, an interpretation of the ophthalmoscopic appearance, and discussion regarding histologic examinations of retina and nevi, as well as concerning psycho-

somatic symptoms. Also considered are cerebrospinal fluid, radiography, encephalography, ventriculography, arteriographic findings, relationship to other retinal vascular anomalies, and treatment. (26 figures, references.)

M. Lombardo.

12

VISUAL TRACTS AND CENTERS

Araujo, Helio de. **Snake poisoning and ocular disturbances.** Arquivos da Soc. de Med. e Cir. de Ilheus, abstracted in Arquivos Brasileiros de Oft., 1943, v. 6, Dec., p. 222. (See Section 16, Injuries.)

Crespi Jaume, Gonzalo. **Unilateral ocular secretomotor syndrome.** Arch. de la Soc. Oft. Hisp.-Amer., 1942, v. 1, Nov.-Dec., pp. 601-612.

Case report of paralysis of the left external rectus, associated with absence of lacrimal secretion and mydriasis in the same eye. The patient was affected with essential hypertension. The author discusses at length the pathogenesis of this condition, concluding that the lesion, possibly of vascular origin, affected both the nucleus of the sixth nerve and the nucleus controlling lacrimal secretion. The mydriasis could be explained by irritation of the sympathetic. (3 figures, references.)

Ramón Castroviejo.

Duenas, Alfredo. **Diagnosis of localization of optic-tract lesions.** Medica, 1944, v. 3, May-June, pp. 63-95.

A 33-page review of the subject, from a Cuban author.

Falcão, Pedro. **Contribution to the study of cerebral localization.** Arquivos Brasileiros de Oft., 1944, v. 7, Feb., pp. 1-13.

This is a short summary of the bearing of the various cranial nerves upon cerebral localization, particularly in relation to certain signs and syndromes.

McAlpine, P. T. **Hysterical visual defects.** War Med., 1944, v. 5, March, p. 129.

Many functional ocular complaints are precipitated by the rigors of army life. Among the hysterical patients the most common symptoms are asthenopia and blepharospasm. Slightly less common are spasms of convergence and accommodation, anomalies of conjugate deviation and of muscle excursion. Least common is hysterical amblyopia. This last must be differentiated from retrobulbar neuritis, toxic neuritis, and amblyopia due to psychosis or disease of the central nervous system. Nine cases of hysterical visual defect and one of dementia precox simulating hysteria illustrate these statements. Unfortunately, in most of these cases adequate psychiatric examinations could not be obtained.

Robert N. Shaffer.

Rezende, J. de, Jr., and Estrada, W. D. **Mixed syndrome of the orbital apex and the foramen rotundum.** Rev. Brasileira de Oft., 1943, v. 1, March, pp. 149-155.

A man of 23 years was wounded with a shoemaker's knife which, as regards the head wound, penetrated deeply in the temporal region, cutting the superficial temporal artery. There was ptosis of the left upper lid, great reduction in visual acuity on the same side, paralysis of all the external ocular muscles, and hypesthesia of the corresponding supraorbital region. The patient was somnolent. The left cornea and conjunctiva were completely anes-

thetic. A month later the patient had recovered from the general effects of his wounds, but the vision of the left eye was entirely abolished, the optic disc atrophic, and the external musculature of the eye almost completely paretic, although the lid elevator had recovered its function. The anatomic diagnosis is expressed in the title of the article. (6 photographs.)

W. H. Crisp.

Subirana, A. **The classic concepts and modern neurologic acquisitions concerning oculomotor physiopathology.** Arch. de la Soc. Oft. Hisp.-Amer., 1942, v. 1, Nov.-Dec., pp. 578-592.

Brief analysis of some of the most frequent cerebral syndromes associated with ocular paralysis. The differential diagnosis of these syndromes is also briefly discussed. (References.)

Ramón Castroviejo.

Wyburn-Mason, R. **Arteriovenous aneurysm of mid-brain and retina, facial nevi, and mental changes.** Brain, 1943, v. 66, Sept., pp. 163-203. (See Section 10, Retina and vitreous.)

13

EYEBALL AND ORBIT

Corrêa Netto, Orozimbo. **Considerations in regard to a case of complete albinism of the eyes.** Arquivos Brasileiros de Oft., 1944, v. 7, Feb., pp. 13-19.

The only five such cases which the author has observed clinically were of the masculine sex and the white race. The patient whose case is described here was a Syrian, aged 22 years. He had a moderate hyperopia and was able to distinguish colors. The author believes it is a mistake to regard these patients as having a congenital weakness of the retina. Albinos should not be permitted to intermarry. (One photograph.)

W. H. Crisp.

Davis, J. S. **Osteomyelitis with fistula, orbital cellulitis and abscess, and diplopia complicating pansinusitis.** Annals of Otol., Rhin., and Laryng., 1943, v. 52, Dec., p. 906.

The author reports this case because it presents several complications of nasal sinus infection at one time, with recovery.

On January 1, 1943, the patient developed an "acute head cold," followed one week later by severe pain over the left eye. Two days later, swelling and redness of the left upper lid were present. This swelling continued for several weeks and gradually fluctuation developed. In April a horizontal incision was made into the localized swelling and pus escaped. The incision did not heal, but a fistula developed which continued to drain.

X rays of the sinuses in February, 1943, revealed pansinusitis on the left side; X rays in March and April showed progression of the pathology with necrosis of the floor of the left frontal sinus; X rays in May showed further progression of the disease and revealed a fistula when radiopaque material was injected through the incision in the eyelid.

Eye findings in May, 1943: vision normal in each eye; diplopia present for past two months; left eyeball displaced downward; right lids normal; a sanguinopurulent discharge exudes from left upper lid, where there is a gaping horizontal incision, surrounding this area are redness and induration; right conjunctiva normal; chemosis of the left bulbar conjunctiva, palpebral conjunctiva slightly injected; media clear, fundi normal.

Radiographs showed marked irregularity of the margins of the left frontal sinuses, with some clouding, and a loss of substance along the left orbital ridge. Diagnosis: chronic suppurative pansinusitis, with osteomyelitis of the orbital plate of the left frontal bone, fistula, orbital abscess, and cellulitis and diplopia. When adequate medical care failed, recovery was brought about by radical surgical procedures.

Theodore M. Shapira.

14

EYELIDS AND LACRIMAL APPARATUS

Blumenfeld, Louis. **Rhinocanalicular anastomosis with reconstruction of the lacrimal sac.** Arch. of Ophth., 1944, v. 31, March, pp. 248-249.

In the present report, the author gives a detailed and technical description of his new operative procedure on the lacrimal drainage system. He says that the results of the better-known procedures, namely, those of West, Toti, Mosher, and Halle, have often been disappointing because they use as part of their reconstructive tissue a lacrimal sac that is chronically diseased, fibrotic, the site of strictures, and often in a state of active suppuration. In the author's procedure, healthy normal tissues are used throughout the entire reconstructed lacrimal system, so that the danger of subsequent granulation and stricture is minimized.

The paper includes a very detailed case history of a patient on whom this procedure was used. (4 illustrations.)

R. W. Danielson.

Fernández, J. M. M., and Soto, M. C. **Tuberclelike leprotic lesion of the eyelid.** Arch. de Oft. de Buenos Aires, 1942, v. 17, Aug., p. 462.

A 33-year-old white woman presented a tumorlike infiltrative lesion of the right upper lid extending over the outer two thirds of the ciliary border horizontally, and vertically to the midpoint. This lesion was prominent, violet in its lower portion and ochre-yellow in the rest, and showed marked congestion over its whole surface. There was fine desquamation, and palpation did not elicit any pain. Immediately above this lesion there was a small nodule of the size of a grain of rice and violet in color. There was complete anesthesia to heat, pain, and touch over the areas covered by these lesions. General physical examination, especially of the skin and mucous membranes, was essentially negative. No acid-fast bacilli were found, but histopathologic examination resulted in diagnosis of tuberculoid leprosy. Marked improvement was obtained with chaulmoogra esters. The interest of this case lies in the rarity of leprotic involvement of the eyelid as solitary manifestation of the disease, and in the diagnostic aid rendered by clinical investigation of the sensitivity of the affected region. (Illustrations, photomicrographs.) Plinio Montalván.

Lachman, R. **Dacryocystitis treated with sodium sulfapyridine.** Rev. Oto-Neuro-Oft., 1943, v. 18, Sept.-Oct., pp. 150-151.

The author claims cure of three cases of purulent dacryocystitis with sac irrigations using a solution of soludagenan (sodium sulfapyridine).

Edward Saskin.

Marback, H. **Partial loss of eyelashes.** Arquivos Brasileiros de Oft., 1943, v. 6, Dec., pp. 211-212.

Under the Portuguese title of "Pelada da palpebra" (baldness of the lid), the author reports the case of a

white boy aged 14 years, who came complaining that the lashes were falling out of the outer half of the left eyelids. The boy was of apparently normal build, there was no suggestion of mental disturbance, and there was no evidence of syphilis in the family. The outer half of the left upper lid had no lashes. Three "atrophied" lashes at the nasal end of this defective area came out under very slight traction. There was no blepharitis, and upon expression the meibomian glands yielded normal secretion. The visual apparatus and its adnexa were otherwise normal. There was no abnormal absence of hair on other parts of the body. The patient was watched for forty days, and was then treated empirically with bismuth iodide of quinine. At the end of three months there was no longer any defect as to the lashes, and the condition has since remained normal. (One photograph.)

W. H. Crisp.

Paula Xavier, J. de. **Phenomenon of Marcus Gunn.** Arquivos Brasileiros de Oft., 1943, v. 6, Dec., pp. 213-217.

The patient was a white Brazilian schoolboy aged 11 years. Since the earliest months of life the parents had noticed defective opening of the right eye. Seven excellent photographs show complete closure of the right eye in repose, and more or less complete opening of the eye upon opening the mouth, in movements of the lower jaw to right or left, in protrusion of the mandible, in contraction of the frontalis muscle, and during mastication. The right eye was deviated strongly downward, and this position of the eyeball was not modified by the various actions of the jaw. The pupillary reactions were normal, but the right pupil had a moderate amount of corectopia, the pupil being displaced upward and inward. The uncorrected vision of the right eye was one sixth, unimproved by lenses, while the corrected vision of the left eye was one half. The effect of lateral movements of the mandible was also manifested with the mouth closed.

W. H. Crisp.

Spaeth, E. B. **Ptosis, posttraumatic and hysterical.** Amer. Jour. Ophth., 1944, v. 27, July, pp. 687-692. (3 figures.)

Vila Ortiz. **Contribution to the bibliography of the phenomenon of Marcus Gunn.** Arch. de Oft. de Buenos Aires, 1942, v. 17, Sept., p. 537.

The author reports the case of a 32-year-old woman who showed the typical phenomenon of Marcus Gunn. There was partial ptosis of the left upper lid. During voluntary movements of the lower jaw, the ptosis disappeared entirely and was superseded by marked retraction. The condition was congenital. The literature on the subject is briefly reviewed. (Illustrations, bibliography.)

Plinio Montalván.

15

TUMORS

Ellett, E. C. **1. Metastatic carcinoma of the choroid. 2. General metastasis from a melanoma of the abdominal wall, with paresis of the external rectus muscle. 3. Rubeosis iridis, with melanoma of the choroid and secondary glaucoma.** Amer. Jour. Ophth., 1944, v. 27, July, pp. 726-731; also Trans. Amer. Ophth. Soc., 1943, v. 41, p. 157.

Titche, L. L. **Epithelioma of the conjunctiva.** Med. Bull. Veterans' Admin., 1944, v. 20, April, p. 449.

A reddish elevated mass about 1 by 0.5 cm. overlapped the basal cornea 2 mm. It was freely movable with the conjunctiva and contained numerous small vessels. The eye was otherwise normal. The tumor was excised under local anesthesia. It was diagnosed microscopically as "epidermoid carcinoma, papillary type, low grade." Five months later, only slight conjunctival injection was visible at the site of the tumor. Movability of the conjunctiva convinced the author that no recurrence had occurred.

Charles A. Bahn.

Trevor-Roper, P. D. **Case of neurofibroma of the choroid.** Brit. Jour. Ophth., 1944, v. 28, April, pp. 177-180.

The presenting symptoms of this case were proptosis of the left eye with some limitation of all movements, especially on looking upward. Ophthalmoscopic examination revealed a globular mass almost filling the superotemporal quadrant, with distinct choroidal and retinal blood vessels overlying. X-ray and general examination showed no evidence of metastases or other abnormalities.

Upon exploration of the left orbit, a firm, circumscribed tumor was found extending back from the sclera toward the apex of the orbit. Exenteration of the orbit was done. The socket healed well and has given no trouble. (Date of operation May 14, 1943.)

Pathologic examination revealed a whitish mass adherent to the globe in the region of the insertion of the superior oblique muscle. This mass was irregularly lobulated and was equal in size to the eyeball itself. It was encapsulated and did not invade the orbital tissues. The choroid and retina were stretched over the surface of the tumor. A fairly large scleral perforation was present and the scleral edges had caused constriction of the tumor mass. The sclera was not invaded and its margins appeared to have been separated by direct pressure.

The tumor was composed of elongated cells showing well marked parallel arrangement with many areas of palisading. The tumor was unusually cellular and showed some mitoses. There were well developed fibrous septa, and some small areas of hemorrhage and degeneration were present. The general appearance did not suggest malignancy. The origin of the growth was probably in the intrascleral portion of one of the ciliary nerves, and this would explain the intraocular and extraocular extensions of a noninvasive tumor.

There was no evidence of generalized Recklinghausen's disease and no family history of that disease. (2 illustrations, references.)

Edna M. Reynolds.

16

INJURIES

Araujo, Helio de. **Snake poisoning and ocular disturbances.** Arquiv. da Soc. de Med. e Cir. de Ilheus, abstracted in Arquivos Brasileiros de Oft., 1943, v. 6, Dec., p. 222.

The abstract (by Durval Prado) gives the following details: A 25-year-old Mulatto was bitten by a cobra on the back of the right foot. Six hours after the accident he noted that his right eye "began to swell." In the course of the following day the vision of this eye was gradually lost. A day later, the patient sought medical care for hematuria, buccal hemorrhages,

and abdominal pains. The right eye protruded, and there was an intense conjunctivitis, with corneal ulcer and opacity of the crystalline lens. The left eye was normal. There were no muscular paralyses. The exophthalmos disappeared after a week, but the eye had to be enucleated. The case is perhaps poorly authenticated. Certain cobras project their venom directly into the eyes of their victims, but no such statement is made with regard to the present case.

W. H. Crisp.

Berezinskaja, D. I. **Corneal transplantation in chemical burns of the eyeball.** Viestnik Oft., 1942, v. 20, pts. 1-2, p. 19. (See Section 6, Cornea and sclera.)

Denig, Rudolf. **Prolapse of the uvea.** Arch. of Ophth., 1944, v. 31, March, pp. 232-241.

This paper consists of a detailed analytical discussion of the treatment of prolapse of the iris or ciliary body depending on size and location of prolapse, age of patient, and amount of inflammation. Ordinarily, one thinks of simple excision of a prolapse of the iris, but the author speaks of an iridectomy on each side and terms the procedure "isolation." He says that isolation of a prolapsed portion of the iris consists of complete interruption of connection with its trunk and exclusion from the irritation emanating from the seat of incarceration. Bilateral cyclectomy would have the same effect for an old inflammatory prolapse of the ciliary body.

Denig quotes Spies as saying that the inflammation will not become manifest if the reflexes passing from the focus of inflammation to the centripetal sensory nerves can be excluded. Spies also claims that an already existing inflammatory reaction will heal rapidly after anesthetization of the focus of inflammation. Bruce had followed up these ideas of Spies by studying: (1) the effect on the inflammatory process of transverse section of the spinal cord; (2) the effect of division of the posterior roots on the inflammatory process; (3) the results of experiments on nerve endings.

Denig's experiments are reported under the following headings: (1) scarification of unilateral lacerated subconjunctival prolapse of the uvea; (2) scarification of bilateral lacerated subconjunctival prolapse of the uvea; (3) after unilateral lacerated subconjunctival prolapse of the uvea, strengthening of the sensory vasomotor reflex by psychic influence.

The author then gives a detailed discussion of the pathology and etiology of sympathetic ophthalmia, and proposes a new idea that there may be psychic factors in the causation, so that there would be a possibility of psychotherapy in prevention and cure of the condition. He argues that, next to uveal injury and continued uveal irritation, the vasomotor psychoreflex is the third fundamental factor in sympathetic ophthalmia. (References.)

R. W. Danielson.

Gomes, Brenno. **External ophthalmoplegia from crotal (snake) poison.** Ophtalmos, 1943, v. 3, no. 2, pp. 187-194.

The snake family Crotalidae is abundantly represented in Brazil. The author reports three cases of poisoning by a Brazilian cobra (tropical rattlesnake), the technical name of which is significantly Crotalus terrificus terrificus. The first patient was a mulatto boy aged 14 years. A wound by a cobra

at the root of the left thumb was immediately followed by disturbance of vision, with inability to raise completely the upper lids. He was also unable to open the mouth completely or to protrude the tongue, and swallowing was difficult and painful. When seen two days later he had complete bilateral internal and external ophthalmoplegia. The second patient, a mulatto child aged eight years, stung on the dorsum of the left foot showed similar ocular conditions, but was in a prostrated and semiunconscious condition, and died shortly. The third patient, a man of 27 years, stung in the forearm, had bilateral external ophthalmoplegia. The first and third patients recovered. The mechanism by which the poison produces these results is unknown. In the cases which survive, the ocular disturbances are transitory. (3 illustrations.)

W. H. Crisp.

Harley, R. D. **Keratoconjunctivitis caused by the manzanillo tree.** Amer. Jour. Ophth., 1944, v. 27, June, pp. 628-631. (References.)

Katznelson, A. B., and Smelansky, P. I. **Results of magnet extraction of intraocular foreign bodies.** Viestnik Oft., 1942, v. 20, pt. 3, p. 14.

This is an analysis of 522 cases with successful extractions in 430. The investigation especially sought to determine the significance of the preoperative state of the eye, and the promptness of surgical interference, as factors in the visual result. The tabulated data show that in the presence of infection the results were poor regardless of the promptness with which the foreign body was extracted. Of cases with traumatic iridocyclitis and uveitis the visual results were better in those cases in which surgical extraction of the foreign body was delayed beyond 4 to 10 days. In another series of noninfected cases the results showed gain with surgical delay. The percentage of unfavorable results is higher in cases operated within the first few days.

One table shows the effect of location of the foreign body on final visual acuity. The best results were obtained when the foreign body was located in the anterior ocular segment; but location in the lens vitiated the prognosis. The prognosis became graver with increase in size of the foreign fragment; most of the large foreign bodies were in the posterior ocular segment. With fragments of equal size the prognosis was more favorable if located in the anterior ocular segment. In the same location the prognosis for visual acuity got poorer with increase in size of the foreign body. Injuries to the lens vitiate the prognosis, especially if lens masses escape into the anterior chamber. The most favorable point of entry is the scleral region, but the least favorable prognosis is after injuries of the ciliary body. Corneal perforations are more apt than scleral to become infected. The anterior route for extraction was used in 287 cases. With the foreign body located in the posterior ocular segment it is extracted by the anterior route if the corneal wound is gaping and the foreign body in the vitreous does not exceed 3 mm. in size; if the lens is injured and opaque; and in relatively fresh cases, with fragments smaller than 3 mm., and with transparent lens. The posterior route was successful in 144 cases. These were cases with gaping scleral wounds; with corneal wounds threatened with further injury by a large or irregular foreign body; cases in which extraction by the anterior

route was unsuccessful; and cases in which the foreign body was fixed in the wall of the posterior ocular segment. In spite of the large number of retinal detachments following posterior-route extractions, the visual results as a whole were not inferior to those of anterior route extractions. Most cases of retinal detachment occurred in eyes in which the foreign body had remained a long time and had become encapsulated. Since the introduction of prophylactic diathermy-coagulation, retinal detachment has occurred in only one eye, in which the foreign body had stayed for five months and was attached to the retina.

Ray K. Daily.

Kirwan, E. O'G., and Sen Gupta, M. **Localization and removal of magnetic intraocular foreign bodies.** Indian Med. Gazette, 1943, v. 78, Nov., pp. 530-532.

In the Eye Infirmary of the Calcutta Medical College, cases of eye injury are X rayed after placing a contact lens on the cornea, so that the location of the foreign body can be judged in relation to the position of the contact lens. A Zeiss contact lens is said to cast a very good shadow on an X-ray film. The contact lenses of greater corneal height show most distinctly. A lateral view is taken with the contact lens in place, and an anteroposterior view with the patient lying on his face, with nose and chin touching the X-ray table, the usual precaution being taken to eliminate as far as possible the shadow of the petrous portion of the temporal bone. The anteroposterior view should not be taken with the contact lens in place, because of the possibility that the shadow of the contact lens may overlap that of the foreign body. The authors give seven illustrative cases. (One diagram in text, a plate containing 12 reproductions of X-ray films, references.)

W. H. Crisp.

Kochkonogov, M. I. **Injury of the orbit with indelible pencil.** Viestnik Oft., 1942, v. 20, pts. 1-2, p. 63.

To 11 cases reported in the literature the author adds one. A man 41 years old fell, and was struck in the left eyelid by an indelible pencil protruding from the pocket of a bystander. The lid became swollen and a bluish secretion exuded from the wound. On opening the wound a piece of indelible pencil 4 mm. long was found. It was removed and the tissues around it excised. The patient made an uneventful recovery. Unless the pencil with the stained tissue is promptly removed, the aniline dye sets up an aseptic necrosis of the tissues, which results in chronic inflammation with encapsulation and cyst formation, so as to require repeated surgery and to leave disfiguring scars.

Ray K. Daily.

Lijó Pavía, J., and Lachman, R. **Hole in macula due to trauma from light.** Rev. Oto.-Neuro.-Oft., 1943, v. 18, July-Aug., pp. 107-116.

The authors give indisputable proof that the retina, especially the macular and paramacular areas, is sensitive to trauma from excessive light. The retinal alterations following this type of trauma may be simply functional without fundus lesions, functional with slight transitory fundus changes, or grave with permanent changes as in the authors' two cases of exposure to a solar eclipse. After studying these two cases over a period of two years, they conclude that visual disturbances follow immediately after exposure and affect the fixation center, that fundus changes are not constant and may re-

cede, that Jess's typical annular scotoma is not always present, that peripheral vision may be lost, and that macular degeneration occurs. The most significant finding in the two cases here recorded was respectively a small hole in the right macula of one patient and in the left macula of the other, due to similar exposures to a solar eclipse without ocular protection, some years previous to examination.

Edward Saskin.

Neglo, L. G., and Spector, I. Z. **A case of air embolism in a fracture of the orbit.** Viestnik Oft., 1942, v. 20, pts. 1-2, p. 60.

A ten-year-old boy was struck in the left eye with a stick, and died in the hospital two days later of cardiac failure. The autopsy revealed fractures of the superior orbital wall and of the lamina cribrosa, and cardiac air-embolism.

Norris, S. W. K. **A wasp sting.** Brit. Jour. Ophth., 1944, v. 28, March, p. 139.

The case of a patient presenting symptoms of epiphora, pain, and photophobia in the right eye, of seven weeks duration, is reported. He had previously been treated in three different hospitals for keratoconjunctivitis. Vertical striae, faintly staining, were present over the upper third of the cornea. A subtarsal foreign body was looked for, but all that could be seen was a small papule with a brownish center. The skin of the upper lid was normal. An attempt to remove the brown spot was made, although three different ophthalmologists elsewhere had made five unsuccessful efforts to do this. Nothing was found, but the next morning a fine hair-like structure was seen and removed from the center of the papule.

The patient then gave a history of having been stung on the right eyelid by a wasp. He had refrained from mentioning this fact earlier, because his story had not been believed in the other hospitals. Upon examination by an entomologist, the hair was reported to be "the distal part of the lancet of the sting of a wasp."

The next day after removal of the sting, the patient was symptom-free, with vision of 6/6 in each eye.

Edna M. Reynolds.

Schench, H. P., Silcos, L. E., and Godfrey, E. W. **Eye casualties treated on a hospital ship.** United States Naval Med. Bull., 1944, v. 42, April, pp. 802-821.

In this survey of 3,019 patients, 38 percent were admitted for injuries directly due to combat. 451, or 15 percent, sustained eye injuries of varying severity. The majority were admitted 6 to 8 days after injury and remained on ship board from 36 hours to 8 days. 80 percent of the eye casualties also had other wounds. Injuries to the eyelids were very frequent, burns occurring in 212 patients, almost all being flash burns. The most satisfactory primary treatment consisted of thorough cleansing with soap and water and removal of crusts, débris, and necrotic material. Wet compresses of saturated boric-acid solution were then used continuously and microcrystalline sulfathiazole powder was applied several times daily. Daily conjunctival irrigation was followed by 2-percent butyn ointment with metaphen or merthiolate. Early Thiersch grafts were used when advisable. Unfortunate sequelae of lid wounds may be minimized by prompt repair based on sound anatomic principles. Repair of the orbicularis muscle is essential for good cos-

metic result. The following procedures are important: (1) intermarginal sutures, (2) closure of conjunctival wounds to prevent adhesions to the globe, (3) additional sutures near the cilia to prevent notch formation, (4) accurate approximation of skin edges. Corneal burns occurred in but 27 of the 212 lid-burn cases. Shrapnel fragments were responsible for most of the corneal injuries. In extensive corneal lacerations human hair was used for suture material. In concussion injuries it must be remembered that the critical distance of high explosive is four times as great under water as in the air. The commonest findings in blast injuries are conjunctival hemorrhage, photophobia, and night blindness. In compression injuries paracentesis was of no value. The lacerated globe is usually less apt to suppurate than the shattered globe, which fact may have a bearing on sympathetic ophthalmia. All of the patients with penetrating wounds received tetanus toxoid, sulfonamides by mouth, and, when indicated, intravenous typhoid-vaccine. 136, or 30 percent, of the eye casualties had foreign bodies in the eyeball or adnexa. Of these at least one half were magnetic. In their localization opaque corneal and scleral markers or clips fixed to the lids were employed. Nonperforating foreign bodies were removed under the biomicroscope with a Ziegler knife. Sclerotomy incisions were rimmed with diathermy needles to prevent later retinal detachment. Injuries to the bony orbit were noted in 14 patients, all of whom had edema or hemorrhage in the orbital tissue. Sulfonamide therapy was considered an important adjunct. Lid suture was frequently employed. Local anesthesia was generally employed. Intravenous sodium-pentothal was almost exclusively used as a general anesthetic.

Charles A. Bahn.

Schorstein, J. **Compound fronto-orbital fractures.** Brit. Jour. Surg., 1944, v. 31, Jan., p. 221.

The author describes eight cases of compound fronto-orbital fracture and the operative technique he used. In all cases the dura had been torn. In some cases the frontal sinuses were fractured, in others the roof of the orbit was fractured, and in a third group the fracture extended into the ethmoidal cells. In six cases in which an early and radical wound débridement was carried out the results were satisfactory. Two patients who came under the author's care ten days and five months respectively after the injury, and whose wounds received only superficial attention at other hospitals, had delayed recovery complicated by intracranial sepsis. R. Grunfeld.

Scobee, R. G., and Griffey, E. W. **Actinic keratoconjunctivitis.** Amer. Jour. Ophth., 1944, v. 27, June, pp. 632-635. (References.)

Slaughter, H., and Alvis, B. Y. **Pneumo-encephalocele secondary to a puncture wound of the lid.** Amer. Jour. Ophth., 1944, v. 27, June, pp. 617-620. (2 illustrations, references.)

Snow, J. S., and Harley, R. D. **Dermatitis venenata and keratoconjunctivitis caused by the manzanillo tree.** Arch. Derm. and Syph., 1944, v. 49, April, p. 236.

Eighteen patients with dermatitis venenata resulting from contact with the manzanillo (beach apple) tree, which is common along the shores of the Caribbean, were used as subjects

for a study of this type of dermatitis. The dermatitis resembles that produced by other toxic plants, although the onset is rapid. Areas most frequently involved were the face, the forearms, the upper part of the trunk, and the genitalia. Four patients presented a severe keratoconjunctivitis with temporary "blindness" produced by blepharospasm and by denudation of the corneal epithelium.

Treatment of dermatitis consisted of wet dressings and soothing applications. The ocular lesions responded to instillation of anesthetics for relief of pain, and irrigations with isotonic solution of sodium chloride. Patch tests indicated that the sap of the tree was the chief irritating substance. To remove the sap and thus prevent the cutaneous reaction, tests showed that ether, soap and water, and sea water were effective in the order named. Recommended effective prophylactic measures are: (1) prompt immersion in sea water, preferably with eyes open; (2) thorough washing of the entire body with soap and water.

Theodore M. Shapira.

Stallard, H. B. **War surgery of the eye.** Brit. Jour. Ophth., 1944, v. 28, March, pp. 105-135.

Stallard reviews 102 cases of penetrating wounds of the eye with retained intraocular foreign body which were treated at a general hospital serving the Eighth Army in its North African campaign from November, 1941, to May, 1943.

Forty-nine of the wounds were from battle casualties suffered during direct contact with the enemy. Of these, 11 were battle-casualty accidents due to such causes as explosion of booby traps, mines, and hidden hand grenades; 17 were civil accident cases, occurring in men engaged in the repair of vehicles, where such implements as hammer and chisel were used; 25 were due to stupid accidents such as inexpert dismantling of hand grenades fuses, and mines, or tossing hand grenades in play.

Of the penetrating wounds, 56 were through the cornea, 42 through the sclera, 3 through both the cornea and sclera, and in 9 cases the site of penetration was not seen. Prolapse of the uveal tract through a penetrating wound occurred in 29 cases, traumatic cataract in 50, vitreous hemorrhage in 49, vitreous prolapse in 5, and retinal detachment in 2 cases. In this series, 58 soldiers had wounds in other parts of the body.

The intraocular foreign body was localized by the ophthalmoscope in 17 cases. In 7 of these cases the foreign body was extracted by the posterior route (through the sclera). The other 10 foreign bodies, which were nonmagnetic, were not removed, since they showed no evidence of adjacent inflammation. X-ray localization was made in 38 cases. A simple method of X-ray localization with a silver ring stitched to the corneo-scleral junction is described.

Because of the fact that war-missile foreign bodies are so slightly magnetic, extraction through a scleral incision is the method of choice when the foreign bodies are situated behind the lens. The technique of removal by the posterior route is given in detail, with three illustrations. In 73 of the cases here reported, removal by the posterior route was tried; in 32, the anterior route.

Vision was improved in 23 cases, in 47 cases there was no improvement in

vision but all have kept the injured eye to date. Evisceration was done in 7 and enucleation in 13 cases, 7 because of shrinkage and 6 because of the danger of sympathetic ophthalmia. It was impossible to assess the value of treatment with drugs of the sulfonamide group. Generally it was not until patients had reached the hospital that regular sulfonamide therapy could be given. (9 figures, tables.)

Edna M. Reynolds.

17

SYSTEMIC DISEASES AND PARASITES

Farias, Natalicio de. **The importance of nutrition in disturbances of the visual apparatus in schoolchildren.** Rev. Brasileira de Oft., 1943, v. 2, Dec., pp. 95-99.

The author discusses the importance and food value of various articles of diet.

Ferreira, J. A., and Austregesilo, Jr. **Syndrome of Claude Bernard Horner.** Rev. Brasileira de Oft., 1943, v. 2, Sept., pp. 39-40. (See Section 13, Eyeball and orbit.)

Hansel, F. K. **Allergy in otolaryngology and ophthalmology.** Laryngoscope, 1942, v. 52, March, p. 242.

A short review of ocular allergy indicates satisfactory control of 50 percent of 30 consecutive cases of allergic conjunctivitis by means of desensitization and eliminative measures. Unilateral allergic cataract may occur in 50 percent of cases, and in all reported by Beetham a long-standing eczema was present. Owen C. Dickson.

Reisner, D. **Boeck's sarcoid and systemic sarcoidosis (Besnier-Boeck-Schaumann disease).** Amer. Review Tuberculosis, 1944, v. 49, May, p. 437.

A study of 35 cases of sarcoidosis is presented, dealing mainly with clinical observations. The majority of the cases were in Negroes, confirming the observation that in the United States the disease occurs with greater frequency in Negroes than in white persons. Sarcoidosis is inherently a widespread systemic affection with predilection for certain organs or anatomic systems. The prognosis of sarcoidosis depends in a large measure on the extent of permanent and irreparable functional damage resulting from localization of the lesions in special organs, particularly the lungs, heart, and eyes.

The eyes and their adnexa are found to be implicated in a considerable proportion of the cases. In this study about one fourth of the group, or nine cases, had ocular manifestations. Practically every part of the eye or its adjacent structures may become involved in the course of the disease.

Among the nine cases here reported, iridocyclitis was found in five, two showed only corneal and conjunctival changes, and in two enlargement of the lacrimal glands was present without change in the eye itself. Involvement is generally bilateral, though in occasional cases the lesion may be unilateral. The fate of the lesions affecting the eye, especially in the uveal tract, is apparently quite variable. While a number of cases with iridocyclitis show complete and apparently spontaneous healing with restitution to normal, in a good many others permanent damage may cause marked functional impairment, not infrequently resulting in blindness. The cases in which the lesion appeared to be limited to the conjunctiva and cornea, as well as those with involvement of the lacrimal glands, showed com-

plete regression during follow-up observation. Theodore M. Shapira.

Scott, J. G. **Ocular syndrome in onchocerciasis.** Brit. Med. Jour., 1944, April 22, p. 553.

Onchocerca volvulus, the blinding filaria, is endemic in certain parts of West Africa and America. In two cases of this infestation, reported in detail, (1) edema of the upper lid, (2) proptosis, (3) ciliary flush, and (4) edema of the optic nerve occurred as unilateral phenomena. Vision was reduced markedly by the neuritis, but returned to normal in 30 days in one case, in 60 days in the other. Hemorrhages and exudate were seen in the fundus, and microfilariae could be seen floating in the anterior chamber, of the second patient. Many microfilariae were found by skin biopsy in each case.

The syndrome of upper-lid edema, proptosis, ciliary flush, and optic-nerve edema might also be caused by hemorrhage, tumor, infection as from orbital cellulitis, or congestion due to venous or lymphatic stasis. These conditions must be considered in differential diagnosis. The authors think the cause of the syndrome is not lymphatic stasis, but anaphylactic edema caused by Onchocerca volvulus.

Robert N. Shaffer.

Sorsby, Arnold. **Tuberculosis and the eye.** The Practitioner, 1944, v. 152, Feb., pp. 79-81.

Frank tuberculosis of the eye is relatively rare. The major significance of tuberculosis in ophthalmology centers around numerous ocular affections for which a tuberculous etiology is assumed on grounds not always beyond criticism. Of these, phlyctenulosis is the most frequent, 80 per cent of such cases having a tuberculous background. It is an allergic reaction. Of 592 children and adolescents with phlyctenulosis, 84 percent were Mantoux-positive as compared with 15 percent in a control series of 900 children with blepharitis. The author believes that phlyctenulosis is essentially the manifestation of a tuberculous infection plus added debility from malnutrition, vitamin-A deficiency, intercurrent disease, and poor hygiene, which create or increase allergy. Similarly, the uveal tract may be involved in nonspecific allergic reactions manifested as chronic inflammation, especially of the iris and ciliary body. Somewhat similar, but more rare, are sarcoidosis and Heerfordt's syndrome. Charles A. Bahn.

18

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

Ade, C. H. **Ocular problems of war workers.** Jour. Indiana State Med. Assoc., 1944, v. 37, March, p. 96.

Employers and employees are concerned with three major groups of problems in industry. In the first group belong visual errors and job classification, including jobs where danger is of maximum importance, jobs where efficiency is paramount, and jobs where neither special ability nor special safety measures are required. In some special jobs color sensitivity is of importance, and in others accurate depth perception (as in the selection of crane operators). In the second group belong the infectious diseases of the eye. The problem here is prevention of an epidemic. In the third group belong injuries, chiefly by foreign bodies and chemical burns. The industrial physician should have enough special training to recognize and to differentiate potentially serious conditions and to know which of them need the care of

an ophthalmologist. When no physician is present the first-aid worker should possess definite criteria as to prompt and adequate treatment of emergency cases. R. Grunfeld.

Bane, W. M. **The treatment of eye diseases by the general practitioner.** The Journal-Lancet, 1944, v. 64, March, p. 77.

The author gives an exhaustive description of modern treatment of eye diseases including vitamin therapy. The article is written primarily for the general practitioner but is of interest for the ophthalmologist.

R. Grunfeld.

Bell, G. H. **Visual physiology of the cinema.** Brit. Med. Jour., 1943, Nov. 27, pp. 669-671.

In 1941 the Society of Motion Picture Engineering issued a series of recommendations, including the use of a 16-mm. projector as standard for educational purpose. The writer goes into technicalities regarding the sitting distance of the spectator from the film either frontally or laterally, and the position and brightness of the lights. The image projected on a flat screen gives a feeling of depth by variations in size of objects and in light intensity in perspective and parallax. (References, 2 figures.) M. Lombardo.

Burnett, M. C. **Study of blind students in schools of social work.** Outlook for the Blind, 1944, v. 38, April, p. 91.

Brief questionnaires were submitted to the 42 schools in the American Association of Schools of Social Work. At least 19 of these had admitted blind students. The total number of blind pupils involved was 57. The questionnaire was too limited to permit accurate conclusions as to students' success, which seemed to vary with the school involved as well as with the personality and ability of the individual pupil. Most of the schools felt that the blind could function satisfactorily in social work. Though most schools attempted to place them in agencies for the blind, some students have done well in various forms of social work. The author thinks students should be given the responsibility of managing their training and should later be recommended for positions in accordance with their school success, just as are seeing pupils. Robert N. Shaffer.

Campos, Edilberto. **Hilario de Gouvêa, ophthalmologist.** Rev. Brasileira de Oft., 1943, v. 2, Dec., pp. 63-67. (See also next abstract.)

The Brazilian National Academy of Medicine recently celebrated the centenary of the birth of de Gouvêa, who in 1881, in Rio de Janeiro, was the first Brazilian professor of ophthalmology as distinct from general medicine and surgery. At that time every Brazilian ophthalmologist had obtained his training in Europe, there being no teaching of ophthalmology in Brazil. De Gouvêa associated the practice of otolaryngology with that of ophthalmology. W. H. Crisp.

Farias, Natalicio de. **Professor Hilario de Gouvêa.** Rev. Brasileira de Oft., 1943, v. 2, Dec., pp. 81-84. (See also preceding abstract.)

At the age of 68 years, de Gouvêa (born 1823) promoted educational reform in the School of Medicine of Rio de Janeiro, where he had become Professor of Ophthalmology at the age of forty years. He had received his education in the medical schools of Brazil, France, and Germany. During

political exile in France, at the age of fifty years, he specialized in otolaryngology, and at 68 years of age he was made Professor of this subject at Rio de Janeiro. Hilario de Gouvêa died in 1923 of diabetes, after amputation of the lower limb at the thigh.

W. H. Crisp.

Hayes, S. P. **Arithmetic teaching and testing in schools for the blind.** Outlook for the Blind, 1944, v. 38, April, p. 99.

The author states that social utility rather than mental discipline should be the aim in teaching arithmetic to blind pupils, and hence that greater stress on mental arithmetic is indicated rather than drills in fractions, long columns for addition, and so on. He suggests learning the multiplication table up to the square of 25, and thorough knowledge of factoring, cancellation, and the like. In tests of arithmetical problems included in the Stanford Achievement Series the blind pupils ranked close to the curve of the seeing pupils. In arithmetical computation, however, most of the blind are one to three years below normal. This is because the test is loaded with calculations which can not be solved mentally. Various methods of stimulating interest in number work and of improving performance are given. Tests adapted to the blind are discussed. Robert N. Shaffer.

Karpinos, B. D. **Visual acuity of selectees and Army inductees.** Human Biology, 1944, v. 16, Feb., pp. 1-14.

This is a tabulated analysis of the visual acuity of several groups of 1,000 individuals each, taken at random from the examination records of 23,706 selectees and inductees examined at an induction center. In the white group of 1,000, aged 18 to 24 years, 624 had vision of 20/20 in each eye, but in the white group 25 years and over, only 506 had the same vision in each eye. In the colored troops, the numbers were respectively 690 and 594. Of the white selectees of all ages, 59.4 percent had vision of 20/20 in each eye, 83.4 percent 20/40 or better, 87.8 percent 20/70 or better, and 95.9 percent 20/200 or better in each eye. In the first tables, the visual acuities of right and left eyes of 1,000 white selectees are analyzed into ages 18 to 24 years, 25 and over, and all ages. The second table similarly analyzes colored selectees. The third and fourth similarly analyze those of white and colored inductees. Table five deals with the number of specific visions in white and colored groups. Graphs 1, 2, and 3 deal with monocular and binocular specific visions in white and colored selectees and inductees in the three age groups mentioned.

Charles A. Bahn.

Mann, I., and Archibald, C. **A study of a selected group of women employed on extremely fine work.** Brit. Med. Jour., 1944, March 18, p. 387.

Twenty-eight factory workers employed in the inspection of extremely fine spiral filaments were examined with a view to determining the ocular and psychologic factors involved in successful performance of tasks involving accurate vision. The main factors in order of importance are: (1) binocular balance, (2) refraction, (3) psychologic stability. The few ocular complaints in this group came from persons with phorias rather than with high refractive errors. The person applying for exacting jobs involving continuous use of the eyes should be orthophoric on the wing test, should have no hyperphoria, and should have well-developed stereopsis and a corrected visual acuity

of 6/6. Failing this, the subject should be monocular for near vision. Though certain neurotics can make satisfactory adjustment, particularly some anxiety, compulsion, and obsession cases, in general the safest group are good average people not so unduly blessed with imagination or intelligence as to make them dissatisfied with repetitive factory work. Robert N. Shaffer.

Silva, Linneu. **Rational concept of the teaching of clinical ophthalmology in our medical faculties.** Rev. Brasileira de Oft., 1942, v. 1, Dec., pp. 71-81.

This is an inaugural lecture at the Course of Clinical Ophthalmology in the Department of Medical Sciences of Rio de Janeiro. The author emphasizes the well-known facilities of direct examination of the eye and its diseases, as contrasted with more obscure approach to other parts of the body; and deals with the significance of this situation for general diagnosis, particularly vascular and neurologic. He suggests that the teaching of ophthalmology to undergraduate students ought to deal chiefly with those aspects of ophthalmology which do not require elaborate instrumentation, or which have importance for general diagnosis, or which require urgent attention in those areas where special practitioners are not available. A neglected factor in medical teaching is the understanding of educational methods. Teachers in medical schools ought to avoid excessively technical presentation of their subjects, and should aim at clarity and simplicity. W. H. Crisp.

Stinchfield-Hawk, Sara. **Speech training in a nursery school for visually handicapped children.** Outlook for the Blind, 1944, v. 38, Feb., p. 39.

Visually handicapped children are notably retarded in their early efforts at speech because of their inability to imitate from visual forms. Two nursery schools, one in Los Angeles and the other in Boston, are using the noto-kinesthetic method of speech training, with favorable results as shown by personality development and increase in mental development as measured by several of the standard mental tests.

The method consists of association of sounds with various toys or objects by means of tactile and motor activity. This is done as a game. For instance, the sounds "h," "f," "t," may be learned from a toy horse with feet and tail and so forth. The age range in the training group in Los Angeles is from 18 months to six years.

Owen C. Dickson.

Strong, Austin. **I learned what it means to be blind.** Saturday Evening Post, 1944, April 29, p. 24.

In an interesting and sympathetically written article this noted author tells of his experiences at the Seeing-Eye School. For four weeks he was given the basic training taken by every blind student and tried out all the techniques blindfolded, including a nerve-wracking expedition through heavy traffic guided by a Seeing-Eye dog. He passes on to the reader some understanding of what a dog must mean to those in darkness when they find their lives can be trusted with perfect confidence to a new pair of vigilant eyes and ears. Robert N. Shaffer.

Vidal, Joaquim. **Some considerations about ocular hygiene in students.** Rev. Brasileira de Oft., 1942, v. 1, Dec., pp. 83-98.

This reproduces a radio broadcast to the public during the first Inter-American Congress for Prevention of Blindness, and is one of a series of

such addresses organized by the Brazilian Secretariat of Education and Health. Particular attention is given to hygienic rules as to reading, and to the causes of direct injury to the eyes during school life. W. H. Crisp.

Vila Ortiz. **The price of negligence in industrial traumatology.** Arch. de Oft. de Buenos Aires, 1942, v. 17, Sept., p. 595.

The author emphasizes the importance of protective ocular appliances in the prevention of industrial hazards, and discusses the sums actually saved by use of such appliances in large plants, particularly in the United States of America. He argues that the hazards would be avoidable in one hundred percent of the cases if the use of protective goggles were compulsory, the expense of acquiring them being amply repaid by savings in claims and indemnities. (Bibliography.)

Plinio Montalván.

Wanamaker, P. **Training program for teachers of the blind.** Outlook for the blind, 1944, v. 38, April, p. 97.

The teachers at the Washington State School for the Blind are required to qualify for certification on the same basis as teachers in other state public schools. In addition they must qualify in specialized techniques such as ability to read and write Braille. Special certificates are issued in arts and crafts, music, and so on. Those who have been teaching over three years are urged to take refresher courses in the summers.

Robert N. Shaffer.

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ANATOMY, EMBRYOLOGY, AND COMPARATIVE OPHTHALMOLOGY

Anfinsen, C. B. **Distribution of cholinesterase in the bovine retina.** Jour. Biol. Chem., 1944, v. 142, Feb., p. 267.

That chemical substances liberated at autonomic nerve endings may act as mediators of the nervous impulse is supported by a large body of evidence. The rapidity of conduction in nerve tissue suggests that if this is so, high concentrations of cholinesterase must be present at localized points in order to remove the mediator, acetylcholine. Gross distribution of cholinesterase in the central nervous system has been determined.

Retina ideally contains synaptic structures in reasonably isolated and compact form. Studies of cholinesterase activity of selected layers of bovine retina demonstrate the presence of concentration of cholinesterase for the most part in the synaptic layers as contrasted with the nuclear, rod, and nerve-fiber layers. Although this localization can be demonstrated, other factors are still necessary before accepting completely synaptic transmission in terms of the acetylcholine-cholinesterase system.

Owen C. Dickson.

Anfinsen, C. B. **Distribution of diphosphopyridine nucleotide in the bovine retina.** Jour. Biol. Chem., 1944, v. 152, Feb., p. 279.

Diphosphopyridine nucleotide or D.P.N. is an essential component of oxidative and glycolytic systems in tissues, and is found in the retina in greater amounts than in other body tissues.

Because of the ease of obtaining relatively specific tissue layers in the bovine retina, a study was made to localize the site of highest concentration of D.P.N. in this structure.

Results indicate the highest values for the synaptic layers. Values for the

nerve-fiber layer and the inner nuclear layer are omitted because of technical difficulties.

It is well known that D.P.N. is a ubiquitous component of protoplasm, and in combination with specific enzymes serves to carry out certain dehydrogenations. It is logical to assume some correlation between tissue metabolic activity and concentration of D.P.N.

Since it is known that the formation of acetylcholine from pyruvate and choline is an oxidative process, the high concentration of D.P.N. in the same layers as cholinesterase suggests that this enzyme plays an important part in retinal synaptic transmission chemistry. Owen C. Dickson.

Crozier, W. J., and Wolf, E. **Flicker response contours for the sparrow, and the theory of the avian pecten.** Jour. Gen. Physiology, 1944, v. 27, March, p. 315.

The flicker contour of the house sparrow (Passer domesticus) is duplex—rod and cone contour. The presence of the pecten brings about changes in the "cone" part of the contour when the light time in the flash cycle is varied. The changes are the same as found in the visually simple zebra finch, and for man when provided with a grid shadow, an "artificial pecten." The rod curve is not influenced by the presence of the pecten. R. Grunfeld.

Crozier, W. J., and Wolf, E. **Theory and measurement of visual mechanisms. 10. Modifications of the flicker-response contour, and the significance of the avian pecten.** Jour. Gen. Physiology, 1944, v. 27, March, p. 287.

When there is projected on the retina of man, monocularly, the shadow of a grid which divides the visual field into several distinct areas, not including the fovea, the ordinary properties of the flicker-recognition contour as a function of light-time fraction become markedly disturbed. Upon illumination of separated retinal areas summation of excitations from these several areas occurs, although the total number of acting cone-units does not increase. If the light-time fraction increases to 0.75 and on up to 0.90, the slope of the cone curve becomes sharply increased and there is evidence of an increase in the number of acting cone units. The "rod" curve remains apparently unaffected by the grid shadow.

The changing form of flicker-recognition contour as a function of light-time fraction, produced in man when the illuminated field is divided into parts by a shadow pattern, is normally found in the Taeniopygia castenotis (the zebra finch). The retina of this bird has only cones and has a large, complex, and darkly pigmented pecten, which casts a foliated shadow on the retina. The increase of flicker acuity due to the pecten shadow is considerable when the dark spaces are brief in relation to the light spaces. The effect of the avian pecten is probably to increase the sensory influence of small moving images. It is of theoretic importance that this may be brought about by an actual decrease of the total effective retinal area illuminated. R. Grunfeld.

Evans, T. H. **Nerve branch at superior orbital fissure connecting sixth cranial with component of sphenopalatine ganglion.** Amer. Jour. Ophth., 1944, v. 27, June, pp. 645-646.

Vidal, F., and Malbrán, J. L. **The path of the inferior peripheral homo-**

lateral fibers in the cat. Retinal microlesion. Arch. de Oft. de Buenos Aires, 1942, v. 17, Sept., p. 521.

Under ophthalmoscopic control and by means of Vogt's electrolytic needle the authors first produced a microlesion in the retina. The animal was killed 13 days later and the specimens were studied with the aid of the Swank-Davenport and the Coleman and Bell stains. The experiments show the efficacy of the method employed, since the small number of fibers involved in the retinal microlesion permitted more thorough delimitation of the degenerated areas throughout the tract. They also prove that the inferior retinal fibers are situated along the inferior portion of the optic pathways, with the exception of its last part, where the fibers ascend to reach the dorsal geniculate body. Likewise, the peripheral temporal fibers of the retina run along the lateral aspect of the tract. (Photomicrographs, bibliography.)

Plinio Montalván.

PAN-AMERICAN NOTES

Edited by Dr. M. Uribe Troncoso
500 West End Avenue, New York 24

Communications should reach the Editor by the twelfth of the month

Miscellaneous

Argentina. The III Argentinian Congress of Ophthalmology is scheduled to be held in Cordoba during the second fortnight of October, 1944. The program is as follows:

Official subjects

I. *Plastic ocular surgery.* a) Palpebral and conjunctival autoplasties, by Prof. Dr. Jorge Malbrán; b) Autoplasty of the lacrimal pathways, by Dr. Horacio B. Moulié and Jorge Balza; c) Keratoplasties, by Dr. Ramón Castroviejo; d) Reparative surgery of the orbit. Operations to improve the socket after enucleation and evisceration. Reconstruction of the cavity after enucleation, by Dr. Carlos S. Damel.

II. *Ocular tuberculosis.* A. *General section.* a) History—Generalities—Etiology—Pathogeny, by Dr. Esteban Adrogué; b) Diagnosis (in general), by Prof. Dr. Rodolpho Laje Weskamp, and Dr. Dante J. Yadarola; c) Treatment (in general), by Prof. Dr. Juan M. Vila Ortiz, and Dr. J. López Bonilla (son).

B. *Special section.* a) Tuberculosis of the lids, lacrimal pathways, conjunctiva, cornea, sclera and orbit, by Drs. Baudilio Courtis and Gunther von Grolman; b) Tuberculosis of the uveal tract, retina, and optic nerve, by Dr. Miguel Ibañez Puiggari, Héctor R. Picoli, and Julio Tettamanti.

Official subjects to be presented by non-Argentinian, Latin-American members

1) Occult ocular tuberculosis and tuberculin therapy, by Prof. Carlos Charlin C.; 2) Sulfonamides in ophthalmology, by Prof. Dr. Moacyr E. Alvaro; 3) Diseases of the optic nerve (study of ophthalmoscopic aspects), by Prof. Dr. Ivo Correa Meyer; 4) Trachoma in Paraguay, by Prof. Dr. Jorge Codas Thompson; 5) Sporotrichosis in ophthalmology, by Prof. Dr. Linneu Silva; 6) Ectopia of the lens, by Prof. Dr. Aniceto Solares; 7) Pulsating exophthalmos, by Prof. Dr. Alberto Vasquez Barriere.

Brazil. In order to give the first lecture of the year in the courses of ophthalmology of the Escola Paulista de Medicina, Prof. Jorge Malbrán, assistant professor of ophthalmology of the Faculdade de Medicina of the University of Buenos Aires, came to São Paulo in March, at the invitation of Prof. Moacyr E. Alvaro. Dr. Malbrán chose as his subject for this lesson, "Some therapeutic rules and principles in ophthalmology." Professor Malbrán, with his assistant, Dr. Flaminio Vidal, also gave a series of lectures on the "Optic pathways."

Uruguay. At the National Medical Congress held in Montevideo, March 17th, the following papers relating to ophthalmology were presented in the section on arterial hypertension: Prof. A. Vasquez Barriere, "Acute occlusions of the retinal vessels in cardiovascular diseases (presentation of retinographs)"; Prof. Moacyr E. Alvaro and Dr. Jairo Ramos, "Correlation of arterial pressure with the visual function and its ophthalmoscopic picture."

Postponement of the Pan-American Congress of Ophthalmology. Due to the prevailing difficulties in transportation, the executive officers of the Pan-American Congress of Ophthalmology, in agreement with the local organizing committee in Montevideo, have decided to postpone the meeting until November, 1945, following the same program already published.

Society for the Prevention of Blindness in Mexico. This Society celebrated the twenty-fifth anniversary of its foundation in Mexico with a meeting called, "The scientific week." The proceedings of this meeting have just been published in a handsome volume containing 25 papers. The volume is well presented, and illustrated with photographs of the eyeground and some operations.

Among the papers presented, we notice one from Dr. A. Torres Estrada on the "Pathogeny of punctate keratitis in onchocercosis," and another by Dr. M. Puig Solanes, "A comparative study of diagnostic methods of incipient avitaminosis." Drs. W. H. Hoffman and P. Ramos Baez of Havana on "The blindness of leprosy can be prevented." Dr. L. Sanchez Bulnes on "Operative correction of spastic and senile entropion," and Dr. Manuel Marquez on, "Amblyopias and amaurosis of therapeutic origin."

Certain ophthalmologists of the United States contributed to the scientific program of the meeting. They were: Dr. William T. Davis, Dr. John N. Evans, Dr. Ramón Castroviejo, Dr. Arthur J. Bedell, Dr. Daniel B. Kirby, Dr. Ray K. Daily, Dr. Martin I. Green, and Dr. M. Uribe Troncoso.

There were also papers by Dr. Pacheco Luna of Guatemala and Prof. Moacyr A. Alvaro from São Paulo, Brazil. Dr. Martin I. Green, of San Francisco, and Dr. Dayne of Dallas, were present at the meetings.

Societies

Brazil. The Sociedade de Oftalmologia de Minas Geraes has elected the following officers to serve during 1944-1945: president, Prof. Hilton Rocha; vice-president, Dr. Oswaldo Silveira; secretary, Dr. Ennio Coscarelli; treasurer, Dr. Antonio Isidero.

The Sociedade de Oftalmologia de São Paulo has elected the following officers for the

period 1944-45: president, Prof. Moacyr E. Alvaro; vice-president, Dr Antonio de Almeida; general secretary, Dr. Silvio de Almeida Toledo; secretary, Dr. Arthur Amaral Filho; treasurer, Dr. Aureliano Fonseca; and files, Dr. Paulo Braga Magalhães.

The Sociedade de Oftalmologia e Otorrinolaringologia do Rio Grande do Sul will be served by the following officers during 1944-46: president, Dr. Luis A. Osorio; vice-president, Dr. H. Lubisco; 1st secretary, Dr. Fernando Boges Alves; 2d secretary, Dr. Saul Fontoura; treasurer, Dr. Capt. Alfredo A. P. dos Santos; librarian, Dr. 1st Lieut. Antonio L. Viana.

Personals

Dr. Manoel A. da Silva who is at present studying in the United States as a holder of a Kellogg Foundation–Pan-American Congress of Ophthalmology Fellowship, read a paper on "Ophthalmology in Brazil," at the 52d annual meeting of the Chicago Ophthalmological Society, on April 17, 1944.

Dr. Daniel Silva of Mexico, D.F., older member of a Kellogg Foundation–Pan-American Congress of Ophthalmology Fellowship, who is at present studying in the United States, read a paper on "Ophthalmology in Mexico" at the 52d annual meeting of the Chicago Ophthalmological Society.

Dr. Augustin Perret of Caracas, holder of a Kellogg Foundation–Pan-American Fellowship and at present studying in the United States, read a paper on "Ophthalmology in Venezuela" at the 52d annual meeting of the Chicago Ophthalmological Society, held on April 17th.

In April, at the invitation of Prof. Moacyr E. Alvaro, Drs. Baudilio Courtis and Roberto Beltran Nuñez of Buenos Aires, Argentina, came to São Paulo to give a series of lectures on Contact lenses. These lectures were well attended by Brazilian oculists who showed great interest in the subject.

Obituary

Dr. Raphael Silva, a prominent ophthalmologist of Mexico City, died April 16, 1944, in the midst of his professional activities. He belonged to the generation of older ophthalmologists who created the Mexican Ophthalmological Society more than 50 years ago. Although not a founder, he was amongst the earliest members of the Society, and all his life worked for the development and success of the institution.

He studied in Europe, especially under the guidance of Professor Fuchs in Vienna and Professor Axenfeld in Freiburg. Later he became a collaborator of the Klinische Monatsblatter für Augenheilkunde.

He started the practice of ophthalmology by assisting the distinguished Mexican ophthalmic surgeon, Dr. Fernando Lopez, and soon became a noted surgeon himself. He was appointed to the staff of the Ophthalmic Hospital of Nuestra Señora de la Luz and, later on, became director of the Hospital, a place which he filled faithfully, and with great ability, until his death.

At the opening of the Escuela de Altos Estudios, in 1915, Dr. Silva became professor of ophthalmology, a post which he kept for several years.

During 1930-31, he was appointed director of the Health Department of Mexico, a position which he filled with ability.

He was recently appointed a member of the committee for awarding the Kellogg Foundation–Pan-American Congress of Ophthalmology fellowships. He belonged to the Mexican Academy of Medicine, to the French Ophthalmological Society, and others. His death is a great loss for ophthalmology in Mexico.

NEWS ITEMS

Edited by Dr. Donald J. Lyle
904 Carew Tower, Cincinnati 2

News items should reach the editor by the twelfth of the month

Deaths

Mr. Edward Bausch, Bausch and Lomb Optical Company, Rochester, New York, died July 30, 1944, aged 89 years.

Dr. E. D. Brooks, Kalamazoo, Michigan, died April 14, 1944, aged 89 years.

Dr. Julian H. Buff, Orlando, Florida, died May 10, 1944, aged 52 years.

Dr. Carl Fisher, Los Angeles, California, died June 7, 1944, aged 64 years.

Dr. Lee E. Grant, Detroit, Michigan, died May 31, 1944, aged 73 years.

Dr. Rudolph M. Gunderson, Lake Park, Minnesota, died April 2, 1944, aged 64 years.

Dr. Abell D. Hardin, Dallas, Texas, died May 10, 1944, aged 64 years.

Dr. W. A. Krieger, Poughkeepsie, New York, died May 19, 1944, aged 61 years.

Dr. Daniel J. O'Loughlin, Kankakee, Illinois, died May 8, 1944, aged 63 years.

Dr. Marion H. Powers, Weirton, West Virginia, died May 4, 1944, aged 62 years.

Dr. Paul J. Sartain, Philadelphia, Pennsylvania, died April 9, 1944, aged 82 years.

Dr. Harmon L. Stanton, Evansville, Indiana, died April 23, 1944, aged 50 years.

Miscellaneous

At a recent meeting of the representatives of the professional and administrative services of the Office of the Surgeon General plans were discussed and progress reports made on the medical history of the war. Work on the history has been in progress since August, 1941, under the direction of Col. Albert G. Love of the Army Medical Department. Reports made at the meeting by officers responsible for historical volumes indicated that marked progress is being made in assembling information from medical installations in this country and overseas.

Editors have been selected for the volumes on the medical specialties and the administrative phases of the medical service. In addition to the research and editorial work to be done in the Office of the Surgeon General, historical activities will be carried forward by officers assigned to headquarters of overseas theaters. They will secure first-hand reports of the overall medical services particularly those rendered under combat conditions. Officers in overseas theaters who have had extensive experience with medical and surgical problems peculiar to this war are being asked to record their observations for the history.

Societies

The Southern Medical Association will hold its thirty-eighth annual meeting in Saint Louis, Monday through Thursday, November 12-16, 1944. For hotel accommodations address Hotel Committee, Southern Medical Association, Dr. Joseph C. Peden, chairman, 910 Syndicate Trust Building, Saint Louis 1, Missouri. The Section on Ophthalmology and Otolaryngology has as its chairman, Dr. W. Raymond McKenzie (Baltimore); as chairman-elect, Dr. J. W. Jervey, Jr. (Greenville, South Carolina); as vice-chairman, Dr. George J. Taquino (New Orleans); as secretary, Dr. Elbyrne G. Gill (Roanoke, Virginia).

According to a recent announcement the Chicago Ophthalmological Society is planning a memorial in honor of the late Dr. Sanford R. Gifford in the form of a lecture on an ophthalmologic subject to be delivered annually before the Society. It is hoped that the many friends of Dr. Gifford will take this opportunity to contribute to this lecture fund in honor of the memory of one who made such outstanding contributions to ophthalmology. Contributions may be sent to the secretary of the Chicago Ophthalmological Society, Dr. William A. Mann, 30 North Michigan Avenue, Chicago.

The American Association of Eye, Ear, Nose, and Throat Society Secretaries will meet in Chicago during the Academy convention in October. Among the important subjects to be discussed is "Extension study courses for eye, ear, nose, and throat societies."

The Colorado Ophthalmological Society held the first annual Edward Jackson Memorial Lecture on June 22, 1944. The guest speaker was Dr. A. J. Bedell of Albany, New York. The subject of his address was "Ophthalmoscopy in the diagnosis of human illness." From his many pictures of the fundus he selected those to demonstrate the interesting but less-common observations in certain diseases. The lecture will be published in this Journal.

Personals

Dr. Delbert K. Judd announces the opening of his office at Suite 423, Arcade Building, Kankakee, Illinois. His practice is limited to eye, ear, nose, and throat; bronchoscopy; and plastic surgery.

Dr. Frederick L. Wicks, Valley City, North Dakota, the founder and first secretary of the North Dakota Academy of Ophthalmology and Otolaryngology has resigned as secretary. Dr. Wicks had served for 25 years in that position.

Drs. Charles A. Hargitt, Edwin C. Place, and Michael J. Buonaguro were recently appointed assistant clinical professors in the Department of Ophthalmology, Long Island College of Medicine, Brooklyn.